NSR-23-006-037

Interim Progress Report

on the Transfer of NASA Technology

to Other Federal Agencies

Contract NSR 23-006-037

Submitted

to the

Office of Technology Utilization

National Aeronautics and Space Administration

by

Center for Application of Sciences and Technology

Division of Urban Extension

Wayne State University

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I. FORWARD

In 1965 the Wayne State University Center for Application of Sciences and Technology (CAST) began to consider the possibilities of applying advanced science and technology to social problems in an urban environment. Particular attention was paid to the development of programs between the university and local government. In 1966 two programs were begun: a program for applying aerospace technology to urban management, supported by the National Aeronautics and Space Administration (NASA); and a program for developing a goal-oriented budget structure for the Detroit Police Department, supported by the City of Detroit. During this same time, NASA officials from the Office of Technology Utilization were meeting with representatives of the President's Commission on Law Enforcement and Administration of Justice and the U.S. Department of Justice's Office of Law Enforcement Assistance (OLEA) to discuss possible areas of coöperation. These meetings were a part of the NASA effort to develop interagency programs which would increase the utilization of aerospace-related science and technology. Several meetings were held with Dr. Richard Lesher, Mr. George Howick, and Mr. James E. Mahoney of the NASA Office of Technology Utilization and Dr. Robert Emrich and Mr. Armold Sagalyn of the Commission and the OLEA. These meetings were based on first, NASA's interest in developing interagency programs to increase the utilization of aerospace science and technology; second, the mandate of the Crime Commission to examine all aspects of crime in order to develop a national strategy against crime; third, the authorization of the OLEA to advance the capabilities of law enforcement bodies and assist in the prevention and control of crime; and fourth, the possibility of applying science and technology to law enforcement and crime prevention.

It was agreed that the NASA would support an experimental program at one of its Regional Dissemination Centers to begin the application of aerospace-related science and technology to law enforcement projects supported by the OLEA. Later, Mr. Bruce W. Pince and Mr. Don H. Overly from CAST were invited to meet with Mr. Sagalyn and Dr. Emrich to determine if a program could be developed which would reflect CAST's interests and capabilities in resolving urban problems through science and technology and the requirements of NASA and the OLEA.

The OLEA expressed an interest in introducing CAST and CAST services to OLEA-sponsored research projects. CAST, then, agreed to work with project groups recommended by the OLEA. A proposal was prepared by CAST and submitted to the NASA, and a contract was awarded in December, 1966. Work began in January, 1967.

II. INTRODUCTION

This report describes work performed by Wayne State University under contract NSR 23-006-037 "...for effort to enhance the transfer of NASA-generated technology to other agencies of the government" through 21 March, 1967. This program was an extension of the capabilities developed by CAST as a NASA-supported Regional Dissemination Center. The scientific and technical data provided by the NASA, the CAST information system, and CAST's scientific and technical expertise made possible the development and implementation of this experimental program.

III. PROGRAM OBJECTIVE

The objective of this experimental program was to begin the application of aerospace-related science and technology to current law enforcement programs. A secondary objective was to develop an efficient interagency program between the NASA and the OLEA. The criteria for measuring objective achievement would be first, the utilization of aerospace-related science and technology in law enforcement programs and second, the establishment of new lines of communication between the NASA (and NASA-supported programs) and the OLEA (and OLEA-supported programs).

IV. PROGRAM RESULTS

The program was structured into five phases. This section describes the five program phases and their results.

A. Phase I - Identification of OLEA-sponsored law enforcement projects.

Phase I required the OLEA to identify certain projects which were science/technology-based and which could effectively utilize aerospace-related science and technology. As a part of CAST's proposal preparation phase, the CAST program was explained in detail to OLEA staff. The following CAST services were described, and it was explained that these services would be made available to OLEA project personnel under this experimental program:

1. retrospective search services including:

(a) pre-search analysis of agency requirements by Application Engineers, technical personnel, and professional information retrieval personnel; and

(b) computerized and manual information retrieval from the NASA files provided; and

(c) post-search analysis of the search results by Application Engineers and other technical personnel; and

(d) delivery of evaluated abstracts; and

(e) provision of hard copy from both _International Aerospace Abstracts_ and _Scientific and Technical Aerospace Reports_; and

(f) advisory service concerning use of information with technical advice from other specialists or University consultants as required in order to increase the potential utilization of the information.

2. current awareness program services including:

abstracts of determined interest to the designated agency or agencies. These abstracts will be retrieved from the NASA-provided information file, collated, and disseminated to the designated agency or agencies on a monthly basis.

Mr. Courtney A. Evans, Acting Director of the OLEA, and his staff contacted in the Fall of 1966 nine OLEA-sponsored projects which were already underway to encourage their utilization of CAST services. The nine projects selected were:

St. Louis Metropolitan Police Department--development of a resource allocation model for motorized patrol and experimental evaluation of the effectiveness of resource allocation decisions made using the model.

New York State Identification and Intelligence System--exploration of the utility of developing some means of automated or semi-automated surveillance for stolen cars and the development of prototypes of associated equipments.

Philadelphia Police Department--development of a computer-based model for crime prediction and the testing of patrol strategies.

Pheonix Police Department--exploration of the information requirements of police field personnel.

California Department of Justice--development of a feasibility and design study for a state-wide, criminal justice, computer-based information system.

Federal Bureau of Investigation--creation of a pilot system to test the feasibility of a nation-wide, computer-based police information system for storing and retrieving information on stolen property, stolen motor vehicles, and wanted persons.

District of Columbia Metropolitan Police Department--development of a research and planning bureau; design of a computer-based information system; and design of a new communication system.

The Polytechnic Institute of Brooklyn--development of a macro-model of law enforcement and crime in New York City for use in management decision making.

Ohio State Highway Patrol--performance of a feasibility and design study for a state-wide police information system. Appendix 1 contains a copy of the letter sent by the OLEA and a list of the addressees.

At the recommendation of the OLEA, CAST contacted all of these projects except the Federal Bureau of Investigation. Appendix 2 contains a copy of the letter sent by CAST. In order to prepare for project implementation, CAST contacted by telephone project personnel at each of the projects to explain again the interagency agreement, CAST's capabilities, and CAST's interest in working with OLEA projects. Although general interest was expressed in all groups, only four of eight project groups contacted expressed an interest in participating in the interagency program. These four groups were: the St. Louis Metropolitan Police Department; the Philadelphia Police Department; the California Department of Justice; and the New York State Identification and Intelligence System. Both the NASA and the OLEA were advised of the response of these four groups.

Phase I, then, identified four OLEA-supported projects which indicated an interest in working with CAST and in utilizing aerospace-related science and technology. It is planned that other OLEA-sponsored projects would be contacted at the recommendation of the OLEA.

B. <u>Phase II</u> - <u>Acquaint OLEA-supported projects with CAST services</u>.

Phase II was to acquaint OLEA project personnel with services available through CAST. Letters and telephone calls to all projects except the FBI were used to define available service. Visits were made to the New York State Identification and Intelligence System, the Philadelphia Police Department, and the California Department of Justice. Several attempts were made to visit the St. Louis Police Department, but an appointment could not be arranged with project personnel. Information describing all CAST services was presented and, where possible, discussed.

As a result of analysis and interviews with OLEA staff and OLEA project personnel and CAST's experience with the Detroit Police Department, several examples of potential applications of aerospace science and technology to law enforcement were prepared. These examples were submitted to all of the projects except the FBI with information again describing the experimental interagency program (see Appendix 3). These examples were:

(1) A CAST computer search on miniature transmitting/receiving communication systems and equipment.

(2) A multi-channel, video security warning system. (From Tech Brief 66-10548, "Motion Detection System, 15-Channel.")

(3) A safety helmet with built-in radio transmission/receiving system. (From Tech Brief 64-10015, "Comfortable, Light weight Safety Helmet Holds Radio Transmitter, Receiver.")

(4) A light weight, small, portable TV camera. (From the 1965 Marshall Center Technology Utilization Conference entitled, Technology Status and Trends Symposium. The two papers cited are: "Lenticular Stereoscopic Television" by Chief,

Human Factors Laboratory, SPACO, Inc.; and "Use of Space Vehicle Television Developments for Commercial and Industrial Use," by C. T. Huggins, Marshall Space Flight Center.)

Phase II acquainted selected OLEA-sponsored projects with the interagency agreement and the services available through CAST, and identified possible applications of NASA technology to the field of law enforcement.

C. Phase III - Scientific and Technical Analysis of Problem and Program Areas.

Phase III required analysis by CAST personnel of specific program and problem areas. Attempts were made by phone and letter to organize meetings with technical personnel at each of the projects. It became evident at this point that most of the technical expertise in three of the four projects represented the use of outside contractors. In these three cases, the majority of the work to be performed by the law enforcement agency under the OLEA grant had been subcontracted to outside groups. This meant first, that the proposal for the sub-contract had been developed and approved prior to the grant commitment and second, that the work to be performed under the sub-contract was carefully scheduled and in many cases underway. Use of CAST, then, would have required a re-evaluation of the role of the subcontractor inasmuch as formal agreements had been established between the OLEA, OLEA project groups, and subcontractors.

Since each of the four project groups which had initially agreed to work with CAST reflected a unique situation, a detailed explanation is presented below of the "technical analyses" performed.

(1) Philadelphia Police Department - The principal contacts were Mr. Phillip Carroll, Director of Central Services, and Captain James Herron. The Philadelphia OLEA project was divided into two parts: the first, the development of a computer-based model for the prediction of crime in a small, geographical area and the second, a general management study of the department. Most of the technical research work was being performed by the Operations Research Division of the Franklin Institute Research Laboratories. The proposal for this research was prepared by the Franklin Institute in May, 1966. Attempts were made to meet with researchers from the Franklin Institute, but they were unavailable.

Since the Franklin Institute researchers were unavailable, copies of the CAST Personal Interest Profiles were left for completion by both Philadelphia and Franklin Personnel. Since their project was well underway and was going to be reported at the First Symposium on Law Enforcement Science and Technology in March, 1967, it was felt that little could be done on this project although there was interest in utilizing advanced science and technology.

It was suggested that the Interest Profiles be returned to CAST, and CAST would develop Current Awareness Profiles for individuals in both the Philadelphia Police Department and the Franklin Institute. Further, it was stated that specific problem areas should be communicated to CAST. To date, there has been no further contact.

(2) St. Louis Police Department - The contact was Mr. Joseph W. Larimore, Jr., Project Director, Resource Allocation Project. The St. Louis Project was to demonstrate and evaluate a new patrol technique based upon the prediction of radio service calls by a mathematical model and the flexible use of manpower between police units assigned to answer radio calls only and units assigned to preventive patrol function. The predictive model, called the Resource Allocation Model, was already designed and in use. The project was emphasizing the coding of locations, the definition of geographical segments, adapting information to the model, and devising a method of displaying the information. The project was planned and being executed by System Science Corporation and a Harvard University faculty member along with St. Louis personnel. Operational testing was to begin in January, 1967.

Several attempts were made to set up a meeting. Finally, copies of the Personal Interest Profiles and the four examples of aerospace technology were sent encouraging the St. Louis group, again, to call. No contacts have been made.

(3) New York State Information and Intelligence System (NYSIIS) - The contact at NYSIIS was Mr. J. J. Paley and Mr. Charles Kingston. NYSIIS, a research-oriented service arm of all law enforcement agencies in New York, was working on two OLEA projects: fingerprint detection/information systems and license plate detection systems. Technical analysis divided these two projects into the following technical areas:

Finger-print research and automated systems and semi-automated systems of handling documents.

1. Document handling and transporting. Techniques of handling various finger-print documents. Size of documents, thickness, etc.
2. Pattern recognition - features of fingerprinting, curvature, segments, scanning devices, electronic logic.
3. Filing, structuring and search of file. Information retrieval. Structuring of file with missing elements.
4. Retrieval of fingerprints. Microfilming of documents, etc.

License plate detection, scanning, etc.

1. Micro waves, radar type interrogation, detection of license plates, transponders.
2. System analysis and reporting techniques on a

state-wide basis (stolen cars). Ways of expediting problem, housekeeping, etc.

3. Communications - video transmission, recordings, band width compression techniques.
4. Psychological research on identification methods. What characteristics do people remember?

Other technical areas of interest to NYSIIS are:

1. New techniques for analysis of physical properties (for example, detection and tracing of hair, marijuana, etc.).
2. Computer communications, information retrieval, instrumental results, time-shared computer system on state-wide basis.
3. Better finger prints, internal reflectance, photographic techniques, impressions, plastics, new types of paper surfaces, inks, etc. for fingerprinting.
4. Techniques for analyzing soil samples, transmitting data, etc.
5. Switching techniques with multiple inputs, analogs, digital, mixed mode, etc.
6. Queing theory, binary encoding, analog, etc.
7. Rapid transmission of facsimile fingerprint cards. (126 inputs eventually on state-wide network.)
8. Visual interrogation, display units, cathode

ray tubes, accessing files.

It was agreed that CAST would develop computer searches and Personal Awareness Programs for the above technical areas, and that NYSIIS personnel could contact CAST if other areas were defined. Computer searches are now being structured and run.

(4) State of California Department of Justice - The initial contacts were Mr. Charles A. O'Brien, Chief Deputy Attorney General, and Mr. Arlo Smith, his chief assistant. Mr. O'Brien and Mr. Smith suggested that CAST personnel meet with Mr. Edward V. Comber, Project Director, Criminal Justice Information Systems Design Study. The Criminal Justice Information Systems Design Study was a feasibility and design study for a statewide criminal justice, computer-based information system. This system represented a major commitment of the State of California since in 1965 the State had completed a study which established the feasibility of applying advanced systems technology to solving the justice information program.

Most of the technical work for this information system was to be done under a sub-contract. The Request-for-Proposal (RFP) was prepared in the Fall of 1966, and a bidders' conference was held in December, 1966. Since the technical design specifications of the information system were to be a part of a competitive proposal in response to the RFP issued by the State of California, it was not possible to examine scientific and technical information needs. It was agreed that the group which wins the competition would be put in contact with CAST, and that CAST would explain available services to these technical personnel.

It was strongly recommended that Current Awareness Profile forms be circulated among those in the State government who would be involved in the project, and that these forms be returned to CAST for the development of Personalized Current Awareness Programs. To date, the Profile forms have not been returned.

It was learned in March, 1967, that a California firm won the competition, but that the work plan had not been fully approved.

Phase III began scientific and technical analysis of OLEA-sponsored law enforcement projects. This technical analysis was to have been sufficient for the development of retroactive computer searches and Current Awareness Programs. Only one project, NYSIIS, seems to be amenable to analysis of information needs, primarily because of its long-range research orientation in the field of law enforcement. The other three groups, while concerned with the long-range problems of law enforcement, were working on specific projects with previously developed, specific plans-of-work. One general area which seemed to be of pervasive interest was the application of management science and technology with emphasis on information systems.

D. Phase IV - Dissemination of Aerospace Science and Technology to OLEA-sponsored Projects.

Through March, 1967, the only information disseminated was the examples previously prepared by CAST. It is expected that Current Awareness Profiles will be established, if necessary by inference, for the four projects and any which later agree to participate. If the Personal Interest Profiles are not completed by project personnel, the Profiles will be completed by CAST according to previous conversations and technical analysis. Modifications will be in the Profiles according to comments and reactions by project personnel. Also, retrospective computer searches in the areas of information systems will be run. Specialized computer searches will be run according to specific OLEA project requirements as they are understood.

E. Phase V - Evaluation

The primary objective of disseminating effectively aerospace-related science and technology has not been achieved; neither has the secondary objective of developing an efficient interagency program. During the time this program was being developed and at the time the program was begun, the CAST project staff knew little about the project groups and the approaches being taken. Of critical importance was an understanding of subcontractor relationships. Time and resources did not permit the development of close working relationships with any of the subcontractors or outside technical expertise employed on OLEA-supported projects.

Also, it was not possible to work with the Commission's Science and Technology Task Force at the Institute for Defense Analysis which had begun to define some of the potential applications of advanced science and technology to law enforcements. Further, the feedback mechanisms which are a part of the CAST dissemination program (evaluation of data provided, document requests, requests for new and ancillary data, and the desire to develop new programs) were never applicable due to the inability to work with project personnel and the length of time required to make technical contacts.

V. CONCLUSIONS

Several major problems have limited the achievement of program objectives; these are: delayed startup; few opportunities to analyze technical expertise in OLEA projects; and the existence of pre-arranged relationships between the OLEA, OLEA projects and subcontractors. Plans are being made to resolve the first problem through the request to the NASA for a time extension in the contract. The latter two problems will be resolved by working with the OLEA.

It is expected that, during the next six months, CAST will begin the effective dissemination of science and technology to OLEA-sponsored projects.

Appendix 1

OLEA Advisory Letter to OLEA-Supported Projects

UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF LAW ENFORCEMENT ASSISTANCE
WASHINGTON, D.C. 20530

September 9, 1966

Dear :

The purpose of this letter is to acquaint you with the nature and objectives of an information management system newly available to certain grantees and contractors of the Office of Law Enforcement Assistance which may prove helpful to you in the performance of your OLEA project.

As you know, the National Aeronautics and Space Administration spends billions of dollars annually performing the research, development test and engineering required by law. To make the information resulting from this R & D effort available to the nation at large, NASA's Technology Utilization Division was established and, using a variety of mechanisms, has enjoyed substantial success in effectively transferring aerospace-related science and technology to industrial, medical and educational users.

Recently, OLEA has negotiated an interagency agreement with NASA's Technology Utilization Division under which an experimental effort will be made to transfer aerospace-related scientific and technical data to selected OLEA projects without cost. Wayne State University's Center for Application of Sciences and Technology (CAST), one of the NASA's Regional Dissemination Centers, has been selected to provide scientific and technological information services to OLEA projects. A brochure is enclosed describing in general the services provided by CAST to industry; naturally, special adjustment of the transfer mechanisms will have to be made in order to provide information services to OLEA users, but we are confident that an effective transfer mechanism can be developed. Hopefully, this will permit OLEA grantees and contractors to make use of the hundreds of thousands of documents in 34 areas of advanced science and technology stored in CAST's computer.

You will be contacted soon by a CAST representative to initiate the sequence of events which may result, if you agree, in your selection as a participant in this important experimental effort. Initially, the effort will be limited to not more than ten OLEA projects from among those focusing on scientific and technological applications to law enforcement and criminal justice problems. We think the service has much potential and will be most grateful for your cooperation.

Sincerely,

COURTNEY A. EVANS
Acting Director

Enclosure: CAST Brochure

cc: Mr. Bruce W. Pinc, Director of CAST, Wayne State University
Honorable James E. Webb, Administrator, National Aeronautics and Space Administration

Appendix 2

CAST Advisory Letter to

OLEA-Supported Projects

Police

September 16, 1966

Mr. Philip Carroll
Philadelphia Police Department
Philadelphia, Pennsylvania

Dear Mr. Carroll:

Recently Dr. Courtney A. Evans, Acting Director of the Office of Law Enforcement Assistance, wrote you explaining that Wayne State University's Center for Application of Sciences and Technology (CAST), as part of the National Aeronautics and Space Administration's Technology Utilization Program has been asked to provide scientific and technological information services to OLEA projects.

CAST is presently working with the Detroit Police Department in an experimental program to transfer the results of aerospace/defense-related science and technology to police operations, in Detroit, and we are anxious to begin working with other programs in the areas of law enforcement, crime prevention and public safety.

I would like to meet with you soon to discuss in some detailthe CAST program and how it might assist your project. I will be calling you in the next week or so. If you have any immediate comments or questions, do not hesitate to call.

Sincerely yours,

Don H. Overly
Assistant Director

DHO:cw

cc: Bruce W. Pince
Courtney Evans
Robert Emrich
James E. Mahoney

<u>Appendix 3</u>

CAST-Prepared Examples of Applications

Aerospace-Generated Technology to

Law Enforcement

WAYNE STATE UNIVERSITY

C A S T

TITLE (TRANSMITTER) X (MICROMINIATURIZATION) + (SUBMINIATURIZATION)

COMPANY- WAYNE STATE UNIVERSITY
BIBL. NO. UW04 A/E DO DATE 2/18/67

L=A(1)X(B+C)(2)+(D)(3)

F/Y = Y = 14
ACC = REJ =
ACCEPTANCE RATIO = CATEGORY RANGE

****
****

DESCRIPTORS--

A. TRANSMITTER
B. MINIATURIZATION
C. MICROMINIATURIZATION
D. SUB MINIATURIZATION

N64-29418 CTS Corp Elkhart Ind Research and Development Div.

PRODUCTION ENGINEERING MEASURE FOR SUBMINIATURE, TRANSISTOR TYPE POTENTIOMETERS Quarterly Progress Report, 1 Jan.-31 Mar. 1964.

C L Holmes and D C Kinsey [1964] 17 p

(Contract DA 36 039 SC-85976)

(QPR 11 AD 601867)

One thousand and eight hundred preproduction samples of two styles (flat mount and bushing mount) of subminiature, transistor type potentiometers were fabricated and submitted to preproduction testing. All failures, on visual and mechanical inspection, were due to the stop torque test. Failures also occurred on the rotational life test and on the moisture-resistance test. Minor specification changes have been requested on stop torque and rotational life. These deviations are believed to be realistic, and will result in a highly reliable 3/8-in.-diameter cermet resistor potentiometer. Twenty-four hundred 25,000-ohm bushing mount potentiometers being evaluated on the 10,000-hour load-life reliability study have passed 3,000 hours (7,200,000 unit hours) of testing with very satisfactory results. I.v.L.

N62-12310 Plessey Co., Ltd (Gt Brit.)

PRELIMINARY CONSIDERATIONS FOR THE DESIGN OF A MICROMINIATURE TELECOMMUNICATIONS EQUIPMENT.

T. M. Goss. *In* Microminiaturization; Proc. of the AGARD Conf. on Microminiaturization, Oslo, July 24-26, 1961 p 174-183 (See N62-12297 07-21)

Preliminary considerations for the design of a microminiature telecommunications equipment are described. A low power V.H.F. transmitter receiver has been selected as a vehicle for these considerations. A comparison is made between the several techniques available, and reasons are given for the choice of an inital method utilizing the assembly of separate components. The components considered for use are described, and the results of measurements made on thin film nichrome and tin oxide resistors, and on silicon monoxide and zinc sulfide capacitors, are quoted. The form of the proposed assembly of components and modules is described. Interconnections are based on the use of soldered joints and printed circuits. A volume reduction of about 10:1 on a conventional equipment of similar performance is sought, and a further objective is an improvement in reliability. A failure rate of one equipment failure per 107 component hours, under moderately severe environmental conditions, is the aim. Maintenance of the equipment by module replacement is proposed and factors affecting the economics of this maintenance method are mentioned. (Author Abstract)

N63-13043 Oklahoma State U. Research Foundation, Stillwater

A MINIATURIZED FIFTEEN-CHANNEL TELEMETRY TRANSMITTER FOR UPPER ATMOSPHERE RESEARCH

Oscar L. Cooper Repr. from Proc. Okla. Acad. Sci., v. 42, 1962 p 171-177

(NASA Contract NASr-4)

A miniature telemetry modulator has been designed for use in conjunction with a separate radio-frequency transmitting unit. The combination may be used as a rocketborne fifteen-channel pulse-position transmitter in conjunction with existing ground receiving equipment. It has similar performance features to those of the AN/DKT-7, a larger and heavier airborne transmitter. It can be used to convert as many as 15 separate sources of voltage data into pulse-time information, which is then transmitted to the ground equipment for decoding. A.R.B.

N65-12270*# National Aeronautics and Space Administration, Washington, D.C.

EIGEN NOISE IN WIDE-BAND ELECTROMETRIC AMPLIFIERS [SOBSTVENNYY SHUM SHIROKOPOLOSNYKH ELEKTROMETRICHESKIKH USILITELEY]

N. N. Romanova, A. V. Parshin, and L. B. Ustinova Nov. 1964 17 p refs Transl. into ENGLISH from Pribory i Tekhn. Eksperim. (USSR) no. 3, May-Jun. 1964 p 94-102

(NASA-TT-F-9193) OTS Prices HC $1.00/MF $0.50

The eigennoise of wideband electrometric amplifiers is computed. The conditions for obtaining maximum sensitivity are determined. The effect of the parameters of the input circuit, of the tube, and of the type of scheme on the value of the maximum sensitivity is considered. Author

300-04

N65-12271*# National Aeronautics and Space Administration, Washington, D.C.

ELECTROMETRIC AMPLIFIERS USING SUBMINIATURE TUBES [ELEKTROMETRICHESKIYE USILITELI NA SUB-MINIATYURNYKH LAMPAKH]

A V Parshin and L B Ustinova Nov 1964 13p refs Transl. into ENGLISH from Pribory i Tekhn Eksperim (USSR), no. 3, May-Jun 1964 p 102-107

(NASA-TT-F-9194) OTS Prices HC $1 00/MF $0 50

Four versions of electrometric amplifiers with subminiature tubes are discussed The band pass in three of these amplifiers is increased from 40 to 160 cps with an input resistance of 100 G ohms Technical data concerning the amplifiers are presented, and some special features concerning the design of economical miniature amplifiers by the use of semiconductor devices are discussed. Author

N65-18306# CTS Corp, Elkhart Ind Research and Development Div

PRODUCTION ENGINEERING MEASURE FOR SUBMINIATURE, TRANSISTOR TYPE POTENTIOMETERS Quarterly Progress Report, 1 Jul.-30 Sep. 1964

C L Holmes and D C Kinsey [1964] 17 p

(Contract DA-36 039-SC-85976)

(QPR-13, AD-608934) OTS $1 00

Pre-production testing of 1800 samples of two styles of the subminiature potentiometers resulted in failures only on visual and mechanical inspection, rotational life, and moisture resistance. 1600 samples of both styles are being rebuilt for retesting. Twenty-four hundred units continue on the 10 000-hour load life reliability study, and have completed 7000 hours for a total of 16 800 thousand unit hours. Author

N66-12373# CTS Corp, Elkhart Ind Research and Development Div

PRODUCTION ENGINEERING MEASURE FOR SUBMINIATURE, TRANSISTOR TYPE POTENTIOMETERS Quarterly Progress Report, 1 Jan-31 Mar. 1965

C L Holmes and D C Kinsey [1965] 22 p

(Contract DA-36 039-SC-85976)

(QPR-15, AD-621355)

Eighteen hundred samples were fabricated and tested to SCS-112 Technical Requirement which did not satisfactorily perform all the requirements Sixteen hundred controls were refabricated and retested in an attempt to meet those test requirements which were not met on the first 1800 group After completion of the second test group, test specifications of Technical Requirement SCS-112 had been met satisfactorily on all tests except moisture resistance on the 50 Omega controls of both styles and rotational life testing on the 25 000 Omega bushing mount style Because these two specification requirements are beyond the present state of the art Technical Action Request No 8 was submitted to request a change in test requirements. The 2400 controls on the 10 000 hour load life high reliability study have completed the testing phase with very satisfactory results. A summary of this test data is included Author (TAB)

N66-14230# Radio Corp of America, Camden, N J Defense Electronic Products

MICROELECTRONIC SOLID-STATE DISPLAY ASSEMBLY Interim Development Report, 8 Jun.-1 Sep. 1965

[1965] 29 p

(Contract NObsr-93320)

(IDR-1, AD-623138) CFSTI HC $2 00/MF $0 50

The work performed during this reporting period and described herein involved for the most part preparation for the configuration and fabrication studies that will be performed during the next two quarters The essential features of the program plan, mask fabrication, CdSe preparation, and the testing circuitry are described Tests made to determine the flatness of TiC etched glass and the variation of gap separation in the sandwich structure are also reported The purpose of this program is to perform exploratory development of a Microelectronic Solid-State Display Assembly based on the molecular property of hysteresis in the electrical conductivity of cadmium selenide (CdSe). This hysteresis property can be used as a switch to control an electroluminescent (EL) element, and a major effort of the program is to demonstrate the feasibility of mass producing the CdSe-EL combination for use in low-cost displays. Author (TAB)

200-04

A66-25858
SPACE SCIENCE AND COMMUNICATIONS SATELLITES [WELT-RAUMFORSCHUNG - NACHRICHTENSATELLITEN].
W. Nestel (Telefunken AG, Berlin, West Germany).
(Technische Hochschule Hannover, Hochschultag, Hanover, West Germany, Oct. 30, 1965, Vortrag.)
Flugwelt, vol. 18, Mar. 1966, p. 189-193. In German.
Review of the design and principles of operation of the Relay, Telstar, Syncom, Early Bird, and project-ATC communications satellites. The electronics involved in the launching and operation of a communications satellite are discussed and illustrated. The subminiaturization, micromodule, integral thin-film, and integral semiconductor techniques and their applications in communications-satellite design are examined. The warning is sounded that a country which does not place sufficient emphasis on space research and development is bound to lag behind the leading countries and be unable to compete with these even in fields that are not directly associated with space science. V. P.

N66-18547# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md
MINIATURE AND SUBMINIATURE TUBE WARM-UP STUDIES
S. A. Buckingham, M. H. Stephan, and F. L. W. Moehle Feb. 1956 47 p
(Contract NOrd-7386)
(TG-245-6, AD-626417) CFSTI HC $2.00/MF $0.50
Increasing attention is being paid to the problem of rapid warm-up of the electronic hardware in guided missiles. At present, electron tube specifications afford no control on the tube warm-up characteristics. Described in this paper, are the results of a series of experiments upon commonly used miniature and subminiature tubes, and some of the variables influencing warm-up time are separated and analyzed. A method of improving warmup by short duration over-voltage pulsing of the heaters has been explored. Several approaches are suggested by which the missile design engineer may cope with a requirement for rapid warm-up. Author (TAB)

N66 25960# School of Aerospace Medicine, Brooks AFB, Tex
A MINIATURIZED VHF FM/FM TELEMETRY SYSTEM
Technical Report, Jun. 1963-Jun. 1965
James M. Terry and Dolfo D. Dizon Dec. 1965 16 p refs
(SAM TR 65 84 AD 477334)
A miniature VHF FM/FM telemetry system was developed that will allow simultaneous monitoring of variable parameters. This telemetry system utilized carrier frequencies of 88 to 230 mc. The design of this telemetry system allows for transmission of a wide range of data over an appreciable distance. The telemetry system can be microminiaturized to fit into a one-tooth space. The basic design can be adapted to almost any shape, depending on its application. The transmitter was developed to study tooth contacts and jaw relation of dental patients. The transmitter is also capable of transmitting a number of other physiologic parameters simultaneously with the proper sensor. Author (TAB)

N66-27857# CTS Corp., Elkhart, Ind. Research and Development Div
PRODUCTION ENGINEERING MEASURE FOR SUB-MINIATURE, TRANSISTOR TYPE POTENTIOMETERS
Quarterly Progress Report, 1 Oct.-31 Dec. 1965
C. L. Holmes and D. C. Kinsey 31 Dec. 1965 12 p
(Contract DA-36 039-SC 85976)
(QPR-18, AD-631050) CFSTI HC $1.00/MF $0.50
A total of 300 subminiature potentiometers were fabricated for retesting on rotational life and moisture resistance. Technical Action Request No. 9 was submitted to obtain approval of the moisutre resistance test equipment at CTS of Berne, Berne, Indiana. After approval of the test facility was obtained, 100 potentiometers of the 50 ohm bushing mount style and 100 of the 50 ohm flat mount style were placed on the moisture resistance test. The 100, 25,000 ohm bushing mount controls were submitted to rotational life test. Author (TAB)

X

200-04

N66-31384*# Litton Systems, Inc., Minneapolis, Minn. Applied Science Div

STUDY OF SUBMINIATURE TOTAL TEMPERATURE PROBES Final Report, 25 Jun. 1965-25 Mar. 1966

R. E. Larson and A. R. Hanson 7 Jun. 1966 44 p refs *Its* Rept-2980

(Contract NAS8-20204)

(NASA-CR-76412) CFSTI: HC $2.00/MF $0.50 CSCL 20M

This is the final report of research on subminiature total temperature probes. It summarizes the development and fabrication of several types of small total temperature probes, and presents calibration results obtained for these probes in the wind tunnel probe-calibration facilities. The objective of the study was to develop subminiature total temperature probes which could be utilized in various boundary layer studies. The attainment of small size and the development of the special fabrication techniques required for these small probes were considered more important than satisfying an absolute accuracy requirement. Author

... CTS Corp. Elkhart, Ind. Research and Development Div.

PRODUCTION ENGINEERING MEASURE FOR SUBMINIATURE, TRANSISTOR TYPE POTENTIOMETERS Quarterly Progress Report, 1 Jan.-31 Mar. 1966

C. L. Holmes and D. C. Kinsey [1966] 13 p

(Contract DA-36-039-SC-85976E)

(QPR-19; AD-634975) CFSTI: HC $1.00/MF $0.50

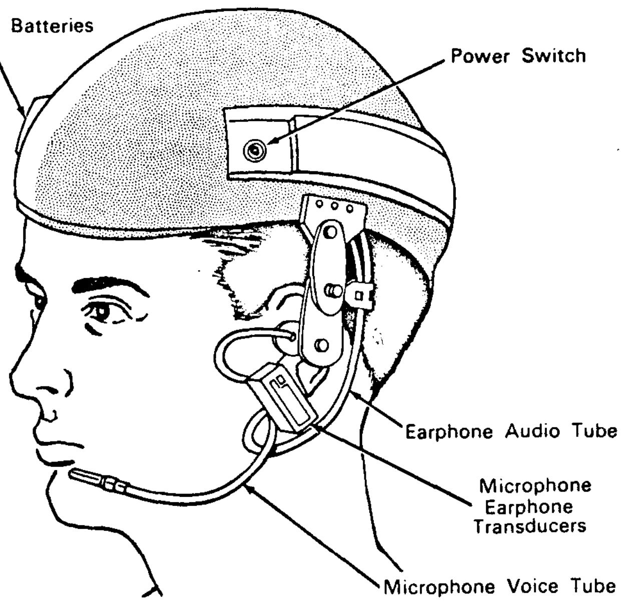
The 300 controls tested in accordance with action II, technical action request no. 8, completed the testing required during this reporting period. All controls tested on the moisture resistance specification passed all requirements satisfactorily. The 100 controls of the 25,000 ohm bushing mount style which were tested on the 25,000 cycle rotational life test had a few controls which exceeded the allowable plus or minus 3% change in resistance with a maximum change of 6.58%. Author (TAB)

300-64

NASA TECH BRIEF

This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

Comfortable, Lightweight Safety Helmet Holds Radio Transmitter, Receiver



The problem: To provide communications by portable two-way radio under circumstances which require the wearing of a safety helmet. To date, safety helmets incorporating self-contained transceivers have been unwieldy and heavy, often with protruding components. Two-way radio components were mounted inside the helmet with only the webbing to prevent them from contacting the skull.

The solution: A lightweight, form-fitting safety helmet incorporating both an inner and outer shell, resilient padding instead of webbing, and a two-way radio located mainly between the two shells. External protrusions are small, permitting the helmet to be worn under other headgear and other protective clothing.

How it's done: The communications/safety helmet is constructed with two nesting hard shells having electronic components and a power supply mounted between the shells. The inner shell is form-fitting and is lined with a resilient padding for wearer comfort and safety. The outer helmet shell nests closely over the inner, but is formed with protrusions, or lobes, on either side to allow more space for mounting the radio components and power supply. A helical antenna is also hidden within the outer shell.

For safety, the microphone arm is made of a flexible material and will not endanger teeth or mouth. When the arm is moved to its stowed position, a power switch automatically turns off the transmitter. A lightweight miniature earphone is made so that

(continued overleaf)

it is interchangeable with an ear-cup type of earphone for use when it is necessary to screen out noise where ambient sound levels are high. Lifting out and turning up the cup-type headset turns off power to the receiver. Microphone arm and earphone may be mounted on either side or, if required, on both sides.

Nickel-cadmium batteries are charged via a plug mounted permanently in the helmet. The plug permits another line, such as an intercommunications system, to be connected into the unit when communications other than radio are desired. If desired, the inner shell can be worn alone as a safety helmet. It can also be worn with a lightweight headset for working in low noise-level areas or plugged into a hand-carried RF transceiver.

Notes:

1. A law enforcement officer wearing this communications helmet could maintain constant communication with others, or with police headquarters, even after leaving his car.
2. Firefighters working in situations where two-way communication is desirable could wear the helmet under standard protective clothing. If a fireman were wearing an asbestos suit, the helmet could provide telemetry to warn of a dangerous temperature increase.
3. Construction workers, in many situations, would benefit by frequent or constant communications afforded by this innovation. Examples include workers assembling large and awkward equipment, pulling electric cable, and directing traffic on big earthmoving projects.
4. For further information about this innovation inquiries may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   P.O. Box 1537
   Houston, Texas 77001
   Reference: B64-10015

Patent status: NASA encourages the commercial use of this innovation. No patent action is contemplated.

Source: Manned Spacecraft Center
(MSC-53)

TECH BRIEF 64-10015

CONSTANT WEAR COMMUNICATIONS HELMET

Source: North American Aviation

Inventor: Norman O. Atlas

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

CONSTANT WEAR COMMUNICATIONS HELMET

PURPOSE

The purpose of this helmet is to provide head protection (bump hat) plus a means of wireless communication. In addition, the helmet is comfortable and can be safely worn when working in such hazardous areas as test facilities.

PRIOR ART SOLUTION

Previous communication type bump hats were heavy, bulky, and so unbalanced that they frequently fell off unless a chin strap was used. The electronic parts were mounted in such a way as to endanger the wearer since the parts were normally mounted between the outer shell and the inner webbing. Mounted this way, the electronic parts could come in contact with the skull if the shell should receive a heavy blow. Finally, protruding parts such as the mike boom and antenna proved to be unwieldy and dangerous not only to the wearer but to other workers as well.

DESCRIPTION OF INNOVATION

This headgear is lightweight, well balanced, will not shake off, and therefore does not need a chin strap (see attached photo). The helmet uses resilient padding instead of webbing and is not as bulky as present helmets of this type. The electronic circuits are contained in the lobes shown protruding from the two sides of the helmet. The helmet can be separated into two hard shells, i.e., an inner and an outer shell. The inner hard shell protects the wearer by preventing contact between the skull and the enclosed electronic parts. The parts themselves are mounted in the outer shell which is snap-fitted to the inner shell. The antenna is a helical type which is completely hidden within the outer shell and therefore does not have any external protrusions. This allows the helmet to be worn under other headgear or under protective clothing such as asbestos fire fighting garb.

The basic shell and padding are shaped to fit the skull to prevent the helmet from falling off, yet the helmet is ventilated. A close fitting helmet such as this allows the wearer to use the headrest in test vehicles. The microphone boom contains a power switch which turns off the transmitter when the boom is moved to the stowed position. As a safety feature, the mike boom is made of flexible material and will not endanger teeth or mouth. The light weight microphone-type earphone is interchangeable with an ear cup type when one wishes to reduce noise in areas of high level ambient noise. The cup type headset lifts out and up to the stowed position to turn off power to the receiver. The mike boom and earphone may be mounted on either the right or left side (or on both sides if stereo or redudancy is desired).

This helmet may be used for physiological sensing and wireless telemetry, for example, electroencephalogram probes can be mounted within the padding.

Physiological sensing and telemetry operation could warn of environmental hazards such as excessive body or air temperature. The transmitter is AM and the telemetry is FM/AM. This can be accomplished by mixing a voltage controlled oscillator signal in with the voice channel, the frequency indicating the value of the parameter being monitored. The transceivers may be used directly as hat-to-hat communications devices or they may be used in conjunction with a "repeater" base station. The storage cells (nickel cadmium) are charged via an umbilical plug mounted in the helmet. The umbilical cord, also permits a "hard line" to be run into the helmet when communications other than radio type are desired.

USES

The inner shell can be worn alone as a safety helmet or it can be worn with a light weight headset for use in low ambient noise areas. It can then be plugged into a local intercommunication system or into a hand carried portable rf transceiver.

When both shells are worn the transceiver could be used as follows:

1. Law enforcement personnel.

   Officer leaving vehicle can maintain constant communication with other officers or headquarters. This feature can be utilized for surveillance work or emergency situations (calls for aid, medical information, etc.)

2. Fire fighting personnel.

   a. Can be worn under standard protective clothing.
   b. Provide 2-way communication for men fighting blaze. Telemetry can be used to warn of temperature increase or condition of air supply in asbestos suit.

3. Construction personnel.

   Men working in remote areas can maintain constant communication where necessary.

   a. Electricians cable pulling, etc.
   b. Assembly of awkward and large pieces.
   c. Surveyors.
   d. Demolition squads.

4. Test personnel.

   a. Alignment and adjustment of equipment in areas not normally provided with intercommunications.
   b. Trouble shooting crews.
   c. Field operations requiring short notice communication installations.

5. Space suit - Pressure suit.

   a. May be used as constant wear head protection containing all necessary communications, physiological, and suit parameter telemetry circuitry.

   b. Can remain on head when donning pressurized helmet and serve as space suit communications source, physiological and suit parameter telemetry source, and as the pressurized helmet liner.

6. Sports

   a. As a crash helmet for sports car enthusiasts. Driver could receive instructions from pit crew.

   b. Traffic and crowd control at sporting events.

COST

The total weight of the helmet is about 19 ounces, of which six ounces are in the helmet itself and 13 in the electronics. The cost of the helmet, as presently constructed by hand layup methods, is approximately $70.00 per item. However, if made by vacuum forming with less expensive material, the cost would probably be in the order of $10.00 each, in reasonable quantities.

The cost of the electronics involved in the helmet depends on the frequency range, power, and reliability required. It is estimated that these electronics would cost anywhere from $40.00 to $1,500.00.

The existing unit was constructed with electronic modules purchased from International Telephone and Telegraph under their trade name of KEL-O-RAD. This unit operates at approximately 30 megacycles, is an AM unit with a power consumption of approximately 100 milliwatts, and costs about $500.00. This unit has all welded construction, which accounts for much of the cost. It is estimated that a similar unit could be made on printed circuit boards for a cost of about $40.00, in production quantities. A one-half watt FM unit is estimated to cost about $400.00. The microphone-receiver assembly was purchased from Pacific Plantronics, Inc., located in Santa Cruz, California. Their commercial microphone-receiver assembly (Model MS-30) costs approximately $60.00. Units meeting military specifications (MS-50) cost approximately $112.00.

Five of these helmets are in test for use on board Apollo. None has been put in service for ground support, principally due to the cost. North American Aviation presently has no plans to market these helmets commercially.

PATENT STATUS

NASA encourages the immediate commercial use of this invention. It is owned by NASA and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA, Washington, D.C. 20546.

MOTION DETECTION SYSTEM, 15-CHANNEL

DATA PACKAGE

for

TECH BRIEF 66-10548

INNOVATOR

R. C. FUSCO

OF RADIO CORPORATION OF

AMERICA UNDER CONTRACT

TO KENNEDY SPACE CENTER

Prepared by

TECHNOLOGY UTILIZATION OFFICER

JOHN F. KENNEDY SPACE CENTER

JOHN F. KENNEDY SPACE CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Kennedy Space Center, Florida

CONTENTS

Flash Sheet No. KSC 66-39

NEW TECHNOLOGY REPORT

TITLE: 15-Channel Motion Detection System

BRIEF DESCRIPTION: This security warning system receives video information from 15 television cameras located in unoccupied areas. When motion is detected by a camera, the system alarm sounds at security headquarters and an appropriate warning indicator lights. In addition, 15 television monitors permit visual surveillance of the areas.

DETAIL DESCRIPTION: The requirement exists in the KSC Security System for a video motion detection system. Currently, no such system is commercially available. One company has designed a prototype, but it works with only one camera and monitor.

The 15-channel system utilizes a commutator and decommutator, allowing time-multiplexed video transmissions over one cable pair. Refer to Flash Sheet No. KSC 66-36 for detailed description of commutator and decommutator operation.

Video signals from the 15 television cameras are sequentially combined within the commutator and transmitted along one cable pair to the decommutator. (Refer to attached block diagrams.) The decommutator reconverts the composite signal to the original video signals and channels them in proper sequence to 15 television monitors. The composite signal to the decommutator is also fed from the decommutator receiver to the detection alarm system. The detection alarm system and the television monitors are housed in an equipment rack.

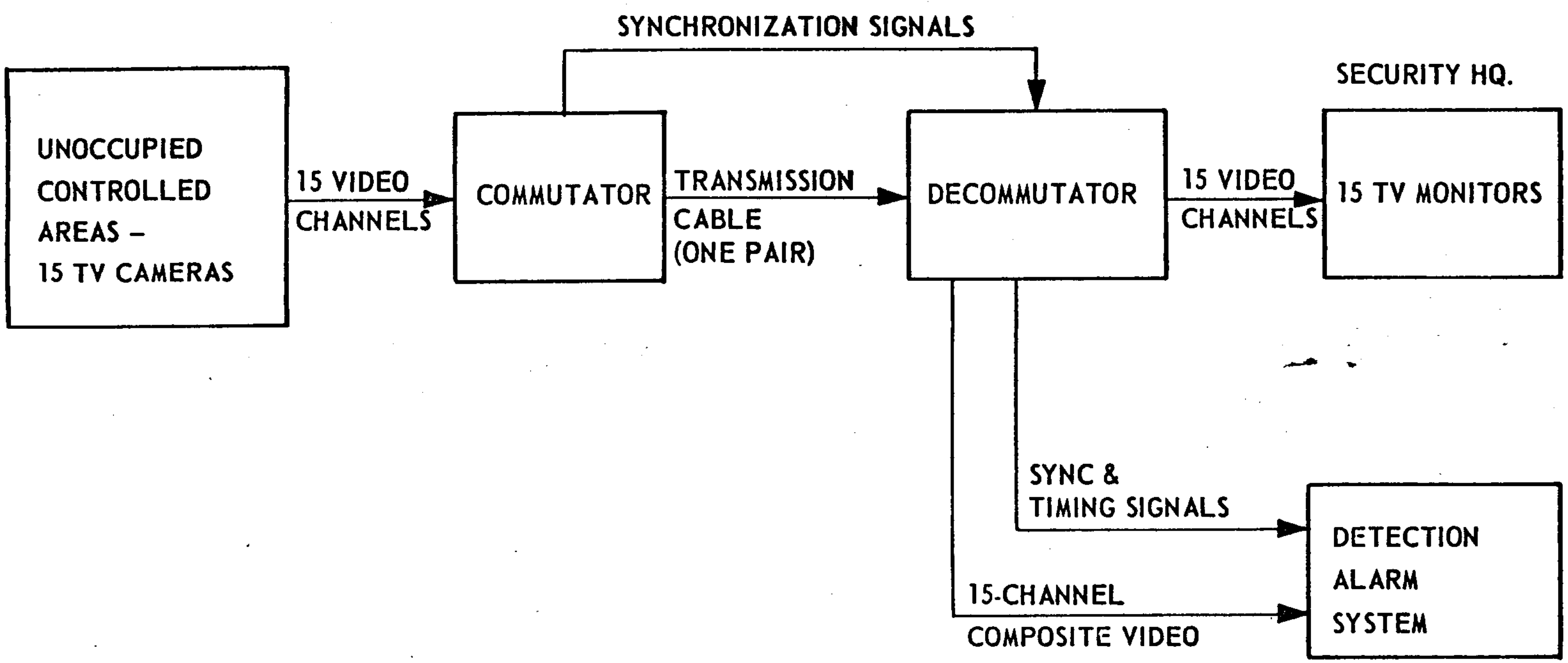
The detection alarm system inverts the first 15 frames (one from each camera) of the composite signal and records them on a video magnetic tape loop. The inverted frames are then played back and compared with the subsequent 15-frame groups received. If there is no motion in the monitored area, these synchronized positive and negative signals will cancel each other. However, if there is motion, the corresponding frames of the video signals will not match, and the system will generate an output to the proper warning indicator and the system alarm.

The initial record phase requires only 1/2 second. One complete scan of 15 frames or channels (1/30 second per frame) is fed through the isolation amplifier to the inverting amplifier and recorded on the video magnetic tape loop. A flip-flop circuit, controlled by a gate signal from a tape control switch, allows only one complete scan of the 15 channels to be inverted and recorded. The second gate signal of the decommutator resets the flip-flop, which, in turn, disables the recording circuit.

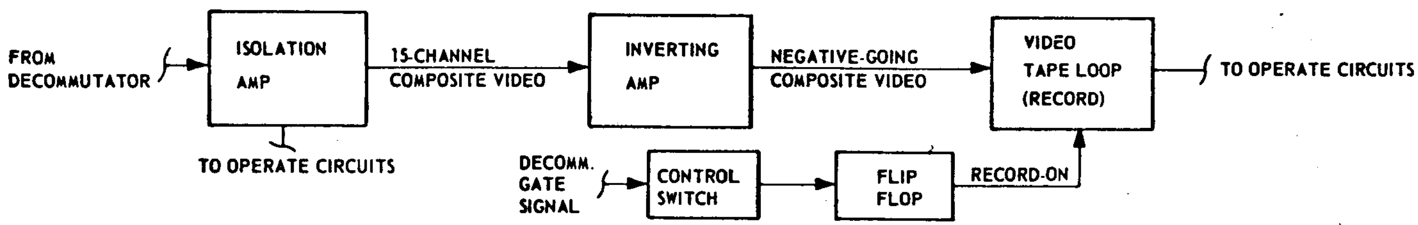
During the operate phase, the video tape recorder plays back the inverted 15 frames of video through an adjustable delay line (to insure proper synchronization) to an adder circuit. The adder circuit receives both a positive-going waveform (the composite video signal from the isolation amplifier) and a negative-going wavefrom (the recorded video signal from the tape loop). The signals are algebraically added in the adder circuit and an output voltage is produced only if there is a difference. A difference will occur if any motion is detected. Regardless of the adder output polarity, one of two Schmitt-trigger circuits will be triggered at a preset detecting level. The Schmitt-trigger pulses are gated and a simultaneous trigger pulse from the Schmitt trigger circuit produces an output from a one-shot multivibrator circuit. The output of the one-shot multivibrator is amplified, energizing a monitor indicator light, the equipment-rack indicator light and the system alarm.

Therefore, if any motion is detected by a television camera, one of the Schmitt trigger circuits will produce an output simultaneously with a gate signal and the appropriate monitor indicator lamp will light. A reset button, located on the equipment rack, will restore any trigger circuit to an operational state when desired.

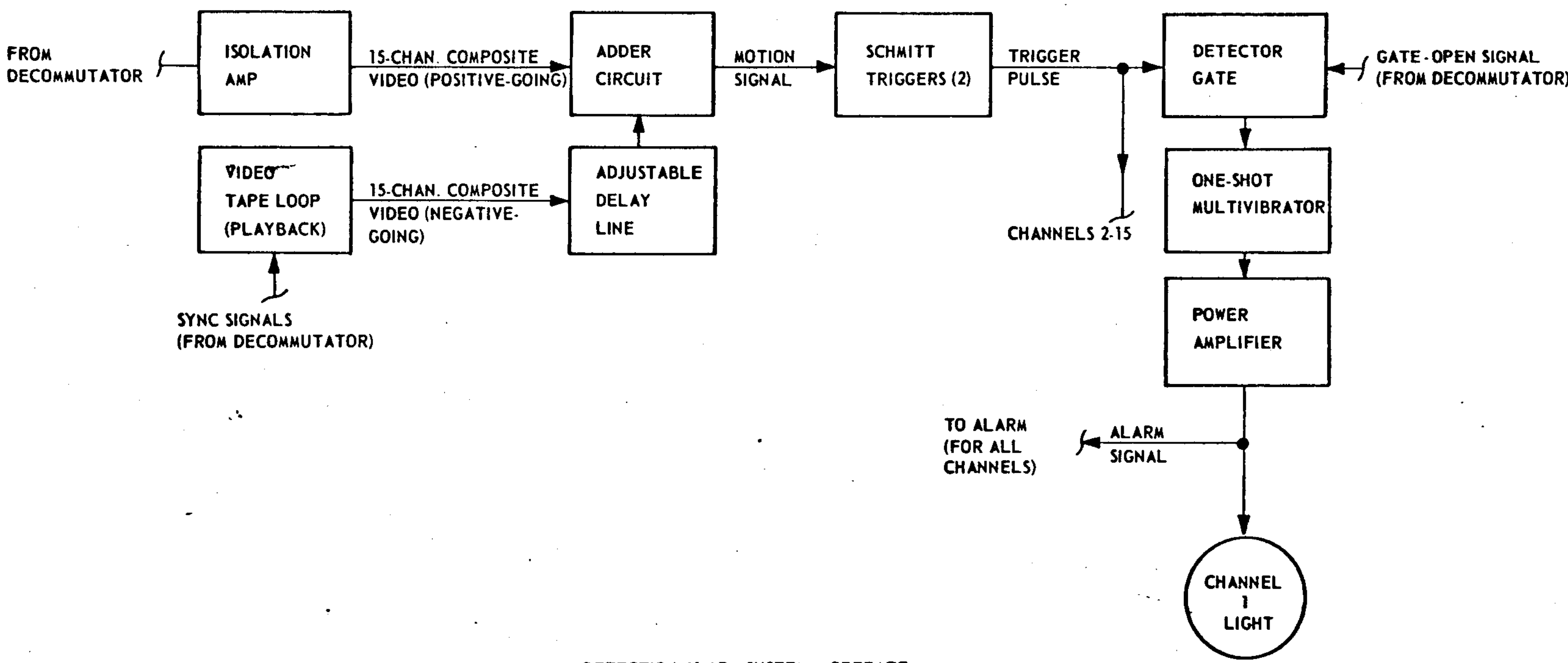
APPLICATIONS: The system could be used in any business to guard merchandise after business hours. Banks, large retail stores, wholesale outlets, and factories are a few examples.



15-CHANNEL MOTION DETECTION SYSTEM



DETECTION ALARM SYSTEM – RECORD



DETECTION ALARM SYSTEM – OPERATE

MOTION DETECTION SYSTEM, 15-CHANNEL

GENERAL

This innovation relates to the development of a 15-channel motion detection system. Using the technology of this system, motion can be detected by 15 remote television cameras and displayed at a single monitor station.

Primary components of the system are 15 television cameras, commutator, decommutator, 15 television monitors in an integrated station display, detection alarm, and related interconnections. Operation of the system is based upon addition of positive and negative video signals. The 15-channel motion detection system compares the first 15 frames of a run with the second and subsequent groups of 15 frames. Each 15-frame group is comprised of one frame from each of the 15 television cameras. Any variation in frames will be displayed on the appropriate indicator and will initiate an alarm signal. The central monitor station guard can then scan the appropriate monitor screen to determine the origin of the motion.

See Flash Sheet No. KSC 66-39 for diagrams relating to this innovation.

PRIOR ART

A commercial prototype has been designed with one camera and monitor to provide for motion detection; however, a motion detection system is not commercially available. Prior art does not exist for a video motion detection system of this design.

DETAILED DESCRIPTION

A television camera is provided for each of 15 locations. Each camera is interconnected with a central monitor station.

An illustration is provided of the rack configuration of the central monitor station. (See figure 1.) The electronic elements of each monitor are contained in one package. These packages are installed behind the panels of the upper and lower sections of the racks. An indicator panel between the monitor groups serves all the monitors on the rack. An audible alarm is interconnected with the rack indicators and is enabled when a rack and monitor indicator are illuminated. A reset pushbutton permits return of the system to a monitor status. Two blowers are provided in each rack to air-cool the electronic components.

The central monitor station receives 15 channels of video information from the 15 remote television cameras. Video signals from the cameras are applied in parallel to the decommutator and through an isolation amplifier to the motion detection system.

One complete scan of 15 channels is coupled through an inverting amplifier and recorded on a video magnetic tape loop. A flip-flop circuit, which can be enabled by depressing the tape control button, allows only one complete scan of the 15 channels to be inverted and recorded. The second gate signal received resets the flip-flop, which in turn disables this circuit.

A video tape recorder plays back the inverted 15 frames of video through an adjustable delay line to an adder circuit. The adder circuit receives both a positive going waveform and a negative going waveform. These signals are added in the adder circuit, and an output voltage is produced only when a difference occurs.

Difference is indicated when any motion is detected by a camera. Regardless of the adder output polarity, one of two Schmitt trigger circuits is triggered at a preset detecting level. The Schmitt trigger pulses are gated by signals from the decommutator. A gate signal from the decommutator and a simultaneous trigger pulse from the Schmitt trigger circuit produces an output from a one-shot multivibrator circuit. The output of the one-shot multivibrator is amplified, energizing a monitor indicator light and a rack indicator light and enabling the audible alarm. A reset button, located on the monitor rack, can be depressed to restore any triggered circuit to an operational state.

CONCLUSIONS AND RECOMMENDATIONS

Technology presented by this innovation is more economical than a similar system using multiple detection circuits. A 15-channel motion detection system is suitable for any large manufacturing plant, mercantile establishment, military installation, or other large facility where security measures are required.

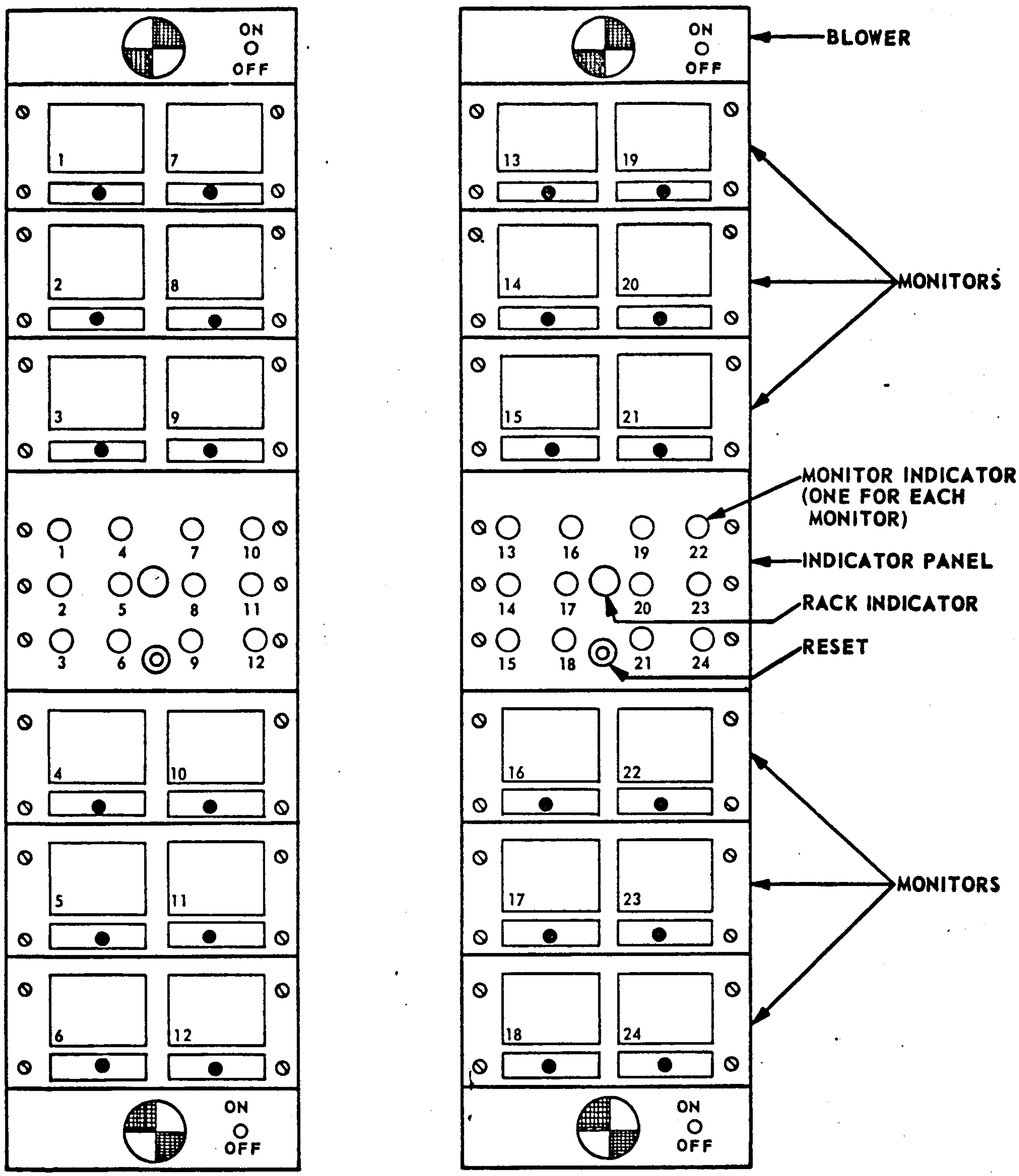


FIGURE I EQUIPMENT RACK LAYOUT

LENTICULAR STEROSCOPIC TELEVISION

By

Chief, Human Factors Laboratory

SPACO, Incorporated
Huntsville, Alabama

LENTICULAR STEROSCOPIC TELEVISION

ABSTRACT

An old optical technique utilizing cylindrical lenses has been adapted to dynamic displays, with particular reference to television. The techniques also apply to motion picture photography and projection.

Two cameras and an electronic switch are required to produce the televi picture. The television display itself is a flat-faced cathode ray tube, but the effect of the lenses in front of the display is to cause each eye to view only those portions of the picture that were derived from the appropriate camera. Thus the viewer sees what he would see if he were looking at th dimensional presentation, and his brain therefore visualizes the presenta as being truly three dimensional. The limitation of the original concept, a later concepts which do not have these limitations, are presented.

USE OF SPACE VEHICLE TELEVISION DEVELOPMENTS FOR COMMERCIAL AND INDUSTRIAL USE

By

C. T. Huggins

George C. Marshall Space Flight Center
Huntsville, Alabama

USE OF SPACE VEHICLE TELEVISION DEVELOPMENTS FOR COMMERCIAL AND INDUSTRIAL USE

ABSTRACT

The application of a technique developed by MSFC for space vehicles for expanding the capacity of a transmission system is discussed as it could apply to commercial and industrial situations. A short history of the development and theory of operation is given using slides and film clips for illustration.

The system is basically a specialized method of time sharing the output of a number of cameras so as to create an interleaved information stream which can be sent over conventional television transmission links such as a long line cable or microwave links. The composite stream of information is separated at the receiving terminal into a number of channels equal to the channels at the transmitting terminal. Each channel may be viewed on a monitor as though it were being transmitted continuously.

Uses of the capacity expansion portion of the system is described as it is related to industrial and commercial applications. Examples of these are multipoint surveillance within two or more plants and multicamera coverage of sports or news events. Also briefly discussed are the new developments which compliment both the transmission and reception ends of the above system.

I. SUMMARY

This paper will describe a technique for transmission of a number of channels of unrelated video and, if desired, audio information over a common carrier medium and allow them to retain their individual identity.

A generalized explanation of the sections and operation of a complete transmission and reception system, of which this is a part, will be covered. A detailed description of the subsystems required for this technique will be given.

Brief discussions are given of the devices developed in support of this technique which are not a direct part but can be used with the system. This applies to both the receiving and transmitting terminal equipment.

Some educational, commercial, and industrial applications of the technique combined with various portions of the peripheral equipment designed with the system are given.

II. HISTORY

During growth of Redstone, Jupiter, and Pershing vehicle development, there were many times when normal measuring instruments and methods failed to give the development engineer a reasonably certain answer to a problem he had with the operation of some part of the vehicle while it was in flight. The measuring instruments used gave such indications as temperature, pressure, acceleration, vibration, shock, and humidity. A single picture in some of these areas would have given the answer.

It was decided in early 1959 to begin design development work on an instrumentation TV system for Saturn research vehicles, for the Astrionics Division of MSFC. Since that time this organizational segment has been engaged in evolving TV systems for use between space vehicles and earth to gain information useful in the development phase of the Saturn systems and to provide real time operational data from the post development vehicles while engaged in the navigation of space. A continuous study was made of the various instrumentation problems as they were presented in the course of the development of the Redstone, Jupiter, and Pershing missiles both as they were related to vehicle systems development and to space navigation as they were inferred.

In the early programs flight times and operational ranges were relatively short. The application of vehicle TV systems then meant that a high picture rate was required with good resolution for the acquisition of as much information as could reasonably be recovered during the short times involved. Commercially available TV subsystems were then providing a capability of 30 pictures per second with the desired resolution. On this and other considerations the decision was made to concentrate, at least in the beginning, on a small extremely rugged camera capable of withstanding environmental extremes expected during powered flight and free space coasting of the test vehicles.

The first complete system assembled included an entire flight system consisting of wideband transmitter, using FM modulation and a miniaturized camera chain capable of withstanding the least favorable launch environment expected, which was at that time the Redstone booster The ground system consisted of a laboratory fabricated receiver, a broadband amplifier and a specially built kinescope recorder. The in-house assembled ground station was operated by laboratory personnel because of their familiarity with the laboratory arrangement of the apparatus.

This system was the first to transmit real time high resolution TV at 30 pictures per second compatible with commercial TV systems from a ballistic missile operating outside the earth's atmosphere. It operated satisfactorily from lift-off to the optical horizon, a distance of more than 320 kilometers on the famed flight of the monkey "Ham" on the Mercury Redstone vehicle, January 31, 1961.

The multiple camera single transmitter system concept was evolved in late 1959 and early 1960 and tested. A proposal including a system description along with details of the test and evaluation of the test results was subsequently submitted to Dr. Wernher von Braun in 1960. Extensive tests of the new camera and lighting concepts for application both on the test stand and in flight, continued until the fall of 1961, at which time it was considered operational for the 1.5 million pound thrust environment of the Saturn booster. It was then included as part of the test program as an instrumentation device for the Saturn system.

Pictures received from this system may be displayed on any standard television system such as the local commercial broadcast television stations or any of the major television networks, which must conform to the Federal Communication Commission's standards for the generation of synchronization signals.

Recent single camera real time pictures made of such things as the deployment of the Echo I balloon and the deployment of the Pegasus payload as well as flights and separation of the stages of the Saturn series vehicles demonstrate the results that can be obtained from flight television systems. The pictures from Echo I, the Saturn series, and the Pegasus were shown over the major commercial television networks.

III. DESCRIPTION OF EXISTING SYSTEM

The Saturn television system provides real time display and permanent storage of pictures televised from the vehicle during flight. The system antidates all known research rocket television systems with inherent commercial television systems compatibility, high picture resolution, and display analysis features. The Saturn TV system is considered applicable to many other research projects where environments comparable to that of the Saturn are expected. The system is modulator in form and, consequently, highly adapted to a wide variety of layout schemes. It is divided into two categories, which are referred to as transmitting and receiving terminal equipment.

Figure 1 shows a simple block diagram of a two camera flight system, employing all of the components mentioned in the transmitting terminal equipment.

Figure 2 shows a simplified block diagram of a ground receiving terminal from the parametric amplifier, which is normally a portion of the antenna system through the monitor and recording system at the other end.

The ground terminal equipment consists of an appropriate receiver connected to a unit called a decoder which separates the combined pictures. This allows the picture originating from each individual camera to be routed to its own individual monitor. The viewing unit is essentially a device employed to store single frames of high rate information and play them continuously to a given monitor so that the picture presented will be at a 30 picture per second rate, while the information received from the vehicle will be at a rate lower than this dependent upon the number of cameras in the system. Information is recorded from the receiver on a video tape recorder and a special kinescope recorder simultaneous with the display on the monitors. A part of the system allows the output from the receiver or the playback from the video tape to be fed into a decoder unit, which separates automatically into two channels the two frames from each camera. The two frames from camera one are fed to output one and the two frames from camera two are fed to output two.

In the first system models the information coming out of these two channels needed to be displayed. If this were fed to a simple television monitor it would produce two frames, or pictures, of information and then omit two frames of information resulting in a 15 cycle per second flicker which occurred every two frames for a duration of two frames. To the eye of the average observer this was very objectionable. However, it was decided then that a device which had the ability to store this information for a short period of time could be used to bridge this two frame gap when no information was being transmitted to the monitor from its own channel. Methods to achieve this will be discussed later.

Figure 3 shows a diagram of the essential parts of both ends of this system. The point of interest for this discussion is the use of the portion of the system lying within the dotted lines. This portion actually changes the capacity of the link joining the two ends of the system. The original concept for the system was to get the maximum amount of information for a given RF bandwidth. Therefore, the first system tried was one which alternated transmission from two cameras on a two frame basis. That is, the end referred to as the video register allowed the output of one camera to pass into the transmitter for two complete pictures and then, during the interval between the second and third picture, the input to the video register unit was transferred to the second camera and two complete pictures from this camera were allowed to pass into the transmitter. The video register would return to the original position and allow two more pictures from the first camera to pass into the transmitter. This back and forth cycling of the pictorial information was received on the ground and video taped. At the same time, a kinescope recording was made. These films would be viewed as individual frames, as any other single frame pictorial information is used without regard to the fact that the information was interleaved on a two frame basis.

Since now each picture was viewed once every 1/15 of a second, the next step in this process was to eliminate the second frame and transmit only one frame from each camera per switching interval. This meant that the motion continuity could be increased and objects having a motion rate twice that capable of being viewed by the first system could be accepted by the new system.

Originally, each picture was viewed 3½ times per second for a series of four cameras. Now each camera output would be viewed for 7½ times per second. Motion studies made of the moving parts of the Redstone, Jupiter, and the Pershing missiles indicated that the usual moving parts such as actuators, separation rates between vehicle parts, etc., normally did not exceed a rate which could be viewed at an information renewal time of 7½ times per second. Therefore, this frame switching system was selected as the first version of the information conservation transmission program and used on the SA-6 developmental flight as a two camera system on a two frame per camera switching basis. The results of this were very good. Switching showed perfect matched registery with no displaced frames or disassociated fields throughout the entire recorded flight.

Since that time, other methods of switching have been employed in the laboratory and have proved feasible. Among these are (1) switching from camera to camera every field, and (2) switching from camera to camera every line. The switching from camera to camera every line imposes motion limitations which increase in severity as the number of cameras go up. However, so long as only two cameras are used most slow motion is not objectional. The field switching system appears to be from this standpoint perhaps the most feasible on the basis of two cameras.

On the basis of four cameras, field switching could be used; however, again there is, the problem of motion continuity between consecutive fields for a given camera and frame switching is best because of the recording of complete pictures from each camera.

IV. DETAILED BREAKDOWN OF SPECIAL SECTIONS OF TRANSMITTING AND RECEIVING TERMINAL EQUIPMENT

A. <u>A description of the video register unit</u>. For purposes of this discussion it will be assumed that four cameras or video signals are being used for transmission over this system. The heart of this system is a four stage ring counter (see figure 4) which is designed to rotate one position every frame or every two fields of video information. The video register contains, as the basic timing system, a crystal controlled oscillator running at twice the horizontal line rate, followed by a binary counter which derives the necessary timing information to control all of the functions of the video register. The signals coming from the timer are used to control the vertical drive signal, the vertical sync, the horizontal sync, the horizontal drive, the sync mixer, the blanking mixer, and the reset or burst generator.

Operation of the device is now given. Video is accepted from one to four sources at commercial frame and line rates. The register unit switches on the single frame or two field basis from one input to the other in rotation. The output from these switches is fed to a video amplifier where the reset or burst generator input is introduced. This shall be discussed later. The video amplifier sends its signal then to the blanking mixer, then to the sync mixer, to the video buffer, and out of the register unit to the transmitter. In order to keep everything in exact synchronization, the cameras are provided with horizontal and vertical drive signals so that their inputs will be exactly in step with the switcher accepting the composite video from each camera. In order to provide some reference point for the decoder, a reset signal is supplied by a video frequency oscillator issuing a single frequency burst of a narrow width. This burst occupies slightly less than one horizontal line at the top of the picture and is not seen on the receiving monitor. This burst is injected into the video amplifier as mentioned above only during the beginning of the first picture from the camera which is arbitrarily chosen as camera No. 1. The ground decoding equipment is able to find this burst and use it as a reclocking pulse to insure that the decoder is continuously locked in step with the video register unit. Figure 7 shows a flight version for shape and size comparison.

B. <u>A Description of the Video Decoder</u>. The video decoder (figure 5) is a device previously mentioned which separates the individual cameras into separate channels displaying them on separate monitors at the receiving terminal of the system. There are two basic parts making up the video decoder - a four stage ring counter and a sync generator or clock. The four outputs of the ring counter operate four video switches. These switches are opened in numerical sequence. The incoming information from either a receiver or a coaxial cable is fed simultaneously to the input of each of these four video switches. It is also fed to a unit called a sync stripper which eliminates the video information from its output leaving only the synchronization information. The output of the sync stripper is fed into the other main portion of the video decoder, the sync generator. This sync generator provides standard output timing and sends pulses to the four stage ring counter at the vertical frame rate, so that the ring counter will rotate one position for each frame pulse delivered to it by the sync generator. Thus the video switches are commanded open one at a time. The video switch 1 opens first sending one frame of video information to a display monitor 1. This switch then closes and video switch number 2 opens. The information from camera 2 is now coming in and is passed through this switch to monitor 2 to be displayed for 1 frame. Then switch 2 is closed and the same procedure is followed with switches 3 and 4 in turn allowing one frame corresponding to the numbered camera at the other end of the transmission medium to pass through each switch. The sync stripper signal keeps the synchronizing generator locked or in phase with the synchronizing generator employed in the video register unit at the transmitting terminal.

There is one other necessary item to insure proper operation of this system without which the position of the counter in the decoder would not stay in phase with the position of the counter in the transmission equipment. If this condition existed the information from the cameras could be displayed on the wrong monitors. To prevent this, as was described previously in the video register section, a burst generator applies a burst frequency at the beginning of the first line of the first field of camera 1. This burst is filtered out by the burst generator filter in the video decoder and appears as a pulse whose width corresponds to the originating pulse or slightly less than one line in duration. This pulse, referred to as the reset pulse, is applied to position one of the ring counter such that if the ring counter is in any other position than number 1 at the beginning of the first picture originating from camera 1, it will immediately shift to position 1 such that the remaining portion of this frame will pass through switcher 1 and on to monitor 1. This is called restoration of frame registery. This insures that each monitor receives the information from its corresponding camera and should it get out of step for any reason during one rotation of the ring counter it will be reset at the beginning of the next rotation. The maximum time that any one monitor could be supplied the wrong information is one frame or in the case of four cameras approximately 1/8 of a second. Figure 6 shows an operational unit designed for rack mounting.

V. OTHER EQUIPMENT PRODUCED AS A RESULT OF THE SYSTEM

As has been explained, the information derived from the video decoder is fed out to a monitor for each camera of the originating system at the transmission terminal. These monitors could be high persistence monitors such that the retention of the image could be held for 1/8 of a second without any appreciable smear so long as the viewed image had very low motion rate - examples being plant surveillance, slowly moving machinery, etc. However, in those cases where the information could move at low rate, a high persistence screen is undesirable. It would be more convenient to supply a conventional monitor displaying 30 pictures per second as is normally done with standard closed circuit TV. It it is desired to view continuously 7.5 or 15 frame per second information it is a necessity to have a long storage time tube and feed it standard 30 frames per second as in conventional close circuit television. There are a number of ways this could be accomplished.

A system first tried and proved successful was a system using a storage tube between the decoder and the monitor. This storage tube was another special development by this Center. It was a requirement that the storage tube have the capability of being able to write in or store one single frame of information in a period of 1/30 of a second, be able to retain this frame of information for a period approaching 1 minute, and then be able to completely erase the picture stored in the tube in less than one vertical interval which is a period of approximately 1100 microseconds.

At the time of the need for this device no such tube existed; therefore, the tube having the qualifications nearest to this was chosen as the most likely candidate. This tube had an erased time of about 2500 microseconds and was reworked so as to reduce its erase time to 1100 microseconds or less. The storage capability of the tube was good for periods of 10 to 20 seconds where erasure was required at 1100 microseconds. Each channel coming out of the decoder would employ one of these storage tubes similar to a monitor picture tube. As each frame of information came out of the decoder it would be fed into a storage tube corresponding to the originating camera in the system. The next frame of information would be switched to the second storage tube corresponding to the originating camera two. During the vertical interval following the picture received from camera number 4, the storage tube associated with camera number 1 would be completely erased, and the next picture from camera number 1 would be written into this storage tube. Observing these tubes visually one could see a small picture approximately 3 by 4 inches which would be similar to the one displayed on the conventional monitor. The resolution of the picture was better than commercial standards, but the shades of gray were not quite as good.

In order to translate this information to a conventional monitor, a small high resolution camera was placed in front of this tube and nned at 30 frames per second. Its output was fed in turn to conventional monitor; therefore, as the storage tube retained its formation the secondary camera continued to deliver to the nitor 30 frames per second. This system was a good beginning.

The second generation of this approach was tried eliminating e optical readout such that the information was read into the tube ectrically and read out of the tube electrically. The storage rface in this particular tube was not visible. This approach, ough reasonable and accurate with respect to each individual ction of the tube, did not prove out realistically when combined. wever, it is thought the basic concept is sound and the idea has t been abandoned.

Another method of translation from the decoder to the standard nitor is by the use of a magnetic drum. The magnetic drum has the pability of storing one frame of information per track per revolution; erefore, one frame of information may be stored upon command and en read out of the drum as long as desired up to about an hour f necessary - the signal noise ratio reduction being the limit on ime. The drums examined to date show that there is a capability of andling two or three times the number of channels of video information per drum compared to the description of this initial system. he drum itself and all its associated drive equipment, in one version, an be mounted in one standard 19-inch rack, along with a monitor and ave form monitor for observing the various channels as they are read into or out of the rotating drum. Another version is much maller but will not accomodate as many channels of information. It does not have as high a signal-to-noise ratio or as wide a bandwidth, but for a number of practical commercial applications would be quite desirable. The life of these machines runs in the order of 2,000 hours before there is any replacement required.

At the transmitting end of the system, the state-of-the-art of cameras is going along very well. The size of cameras and the complexity is being reduced as the resolution capabilities of the cameras is slowly increasing. There is always the question of how much resolution is required or how much is the user willing to pay for a particular job. In connection with this subject, this Center has been engaged in the development of ruggedized cameras for some years as evidenced by those now in use onboard the Saturn vehicle. A special type of tube had to be developed to survive in these environments. Continuation of this development has produced a tube which is a half inch vidicon able to survive the Saturn operational conditions.

Now in final stages of assembly and testing is a camera utilizing integrated circuitry of the micromodular concept for the peripheral equipment associated with the imaging tube which is made from ceramic rather than glass, and is much smaller than any other known tube of the conventional vidicon type made today. This tube has the advantages of low mass, high vibration resistance, the ability to maintain good resolution and withstand considerably higher temperatures than any other tubes currently available. Figure 8 shows an artist's conception of the complete camera package as it might appear ready to be installed. This includes all associated circuitry necessary to produce standard composite video picture. Work is still being carried on in the area of the critical portion of the camera which is the imaging tube. It is felt that the technology of microminiaturization and photosensitive devices can ultimately provide us with a sensor capable of producing television type pictures but having no electron scanning beam and therefore no electron gun to withstand the shock and vibration imposed by launch and maneuvering of space vehicles. This would leave only the temperature and humidity problems which now exist to be overcome as the growth of the art continues.

VI. APPLICATIONS OF A COMMERCIAL AND INDUSTRIAL NATURE

Now let us apply this technique to some applications other than our space program. A few hypothetical cases will demonstrate the versatile use of this system. Suppose a company has a number of plants or buildings situated relatively near to each other. Perhaps now they employ roving night watchmen or they may have installed TV cameras in a central monitoring point in each building to monitor the various areas of the plant during operational or off-duty hours. Using the system described here the cameras located in the given plant could be combined using this time sharing technique because the information usually desired in this case is that of the presence of undesired motion rather than observance of a fast motion rate. These cameras could be combined and transmitted over a single transmission cable to another point where they could be viewed by a single man. Let us suppose that three buildings are employed. The output from each building could be sent, using this technique, over a cable to a central observation point, where one or two men could be employed to observe the entire three plant facility. Now, it is true that if you increase the number of monitors you would have some problems with a symptom which would be comparable to road hypnosis. This may be eliminated by the use of standard redundancy elimination techniques whereby all monitors would have no display as long as there was no moving object in the picture. The minute an object moved in a picture it would appear on a screen. This in itself would be a much more practical approach to psychologically efficient use of the observers.

The current video register unit could be programmed externally over any kind of audio lines available from the observation point to a particular plant to cause the sampling circuitry to stop on a particular camera thereby allowing continuing observance of a particular view, if it was felt necessary by the observer.

The transmission of this information from the plant to the viewing point could be accomplished by conventional coaxial cable and line boosters. For a remote plant it could be done by microwave link if the remote observation warranted the expense of a low cost microwave link, since the bandwidths required are those in commercial use. The use of this technique of observance over a relatively short period of time would pay for the equipment in the saving of roving guards, or night watchmen, or an individual observer for each installation.

In the area of commercial entertainment this technique could again be employed in a somewhat similar manner. In the case of covering sports events of any type where multiple cameras are set up for point observances, the information is usually relayed to some central point by cable or microwave where someone selects the view to be used to feed the network. With this technique the person selecting the view to be fed to the network would not necessarily have to be located at the sight of the event. The information could be transmitted over a microwave link to some remote point where other facilities required for the integrated operation of such a program were also available.

For a particular camera to be transmitted it would simply be necessary for the selector to send a command by means of any hardwire line such as telephone to the central transmission site where the particular camera selected would be held continuously on the feeder line to the network. The feeder line could be at the point of the sports event. The operator or selector referred to above could continue observance of all the other cameras by the above means, and at any time change from one camera to another. The motion continuity problem would not be serious since the general content of the picture could be observed for each camera and only one transmission line or RF link would be needed to accomplish this.

One application of this system which has already been considered in our own area is a link between our launch facility and Houston Control Center. This system would allow a motion continuity of

30 frames per second, but would have lower resolution, if it did not use storage techniques as described earlier in this paper. This will allow Houston to observe many areas essentially simultaneously where motion is either nonexistant or relatively low.

Another use entirely removed from this is for educational television. A system is now in existence which could be used over any TV station or community TV system without interfering with regular programming. This system would allow the teacher to present lecture material on a given subject and then actually provide self test facilities in the home for the home student. At intervals during the presentation, questions would be shown on the screen which has been divided into 4 parts, each offering a different possible answer to the question. The student at home could indicate his selection of an answer by activating one of four buttons on a small unit connected to a special FM receiver. This receiver could be associated with the FM section of the TV set. Activation of this button would cause the TV set to become a decoder and select only one of the four possible solutions and display it on the screen of the TV set. At the same time the audio recording corresponding to this is selected by the decoder so that if the student is correct he gets acknowledgement plus additional reasoning for his answer and additional information. If he has picked the wrong answer the picture and the voice associated tell him where his reasoning went astray. This system would derive its information from a four track tape which would be multiplexed similar to the system already discussed along with a multiplexed audio, and fed into a conventional TV transmitter as video and audio. This multiplex signal could not be intercepted by a standard AM or FM receiver. This could be a great boon to the educational network throughout our country. The sampling rate of the information would be at 7½ times per picture per second repeated continuously. Information could be renewed at 7½ times per second. The multiplexed audio would be sampled at an ultrasonic frequency such that no loss in intelligibility would be lost or be detectable by the ear.

VII. ACKNOWLEDGMENTS

The subject matter of this paper has been discussed with many people, and the author has greatly benefitted from their comments. Where possible, individual acknowledgment has been made.

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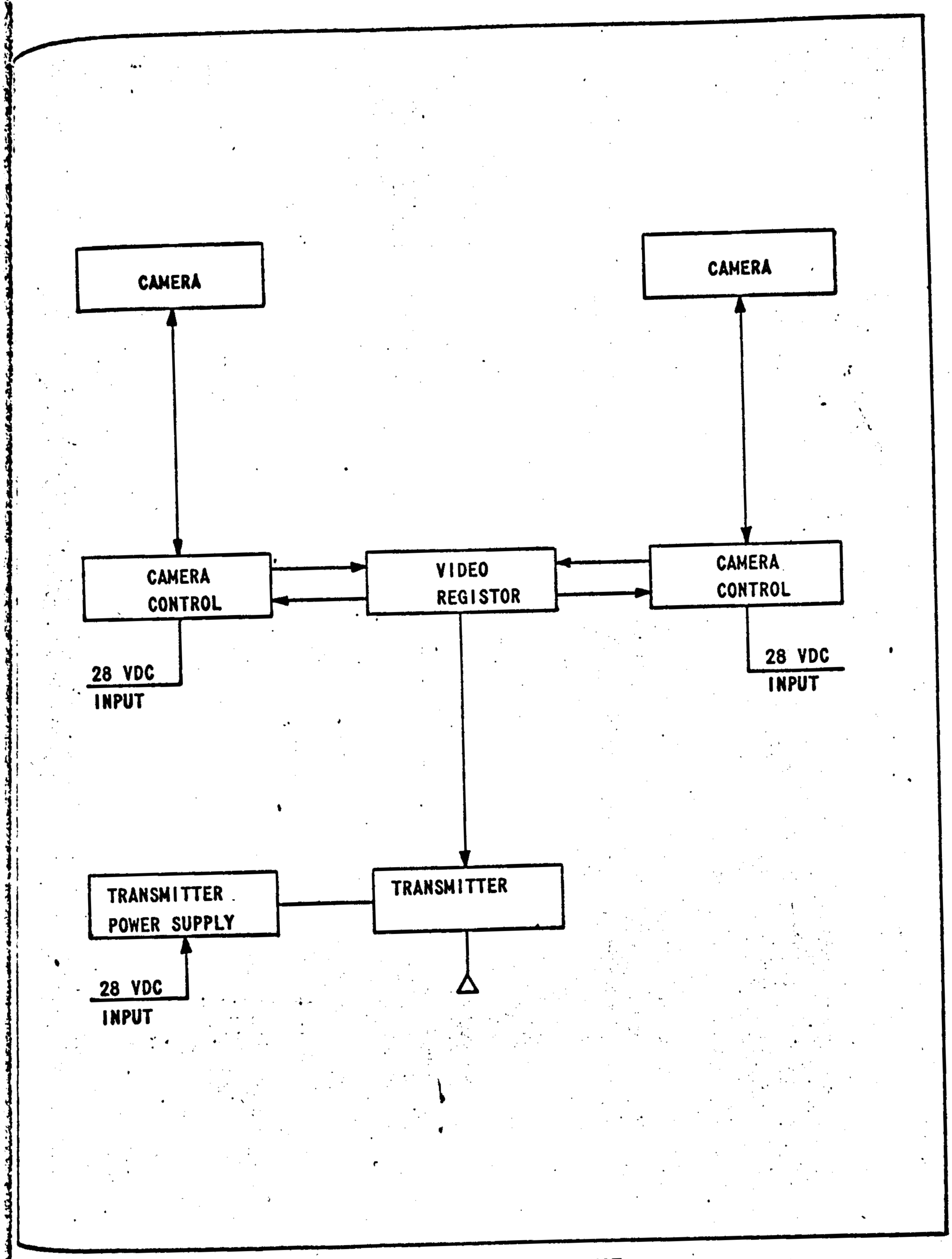
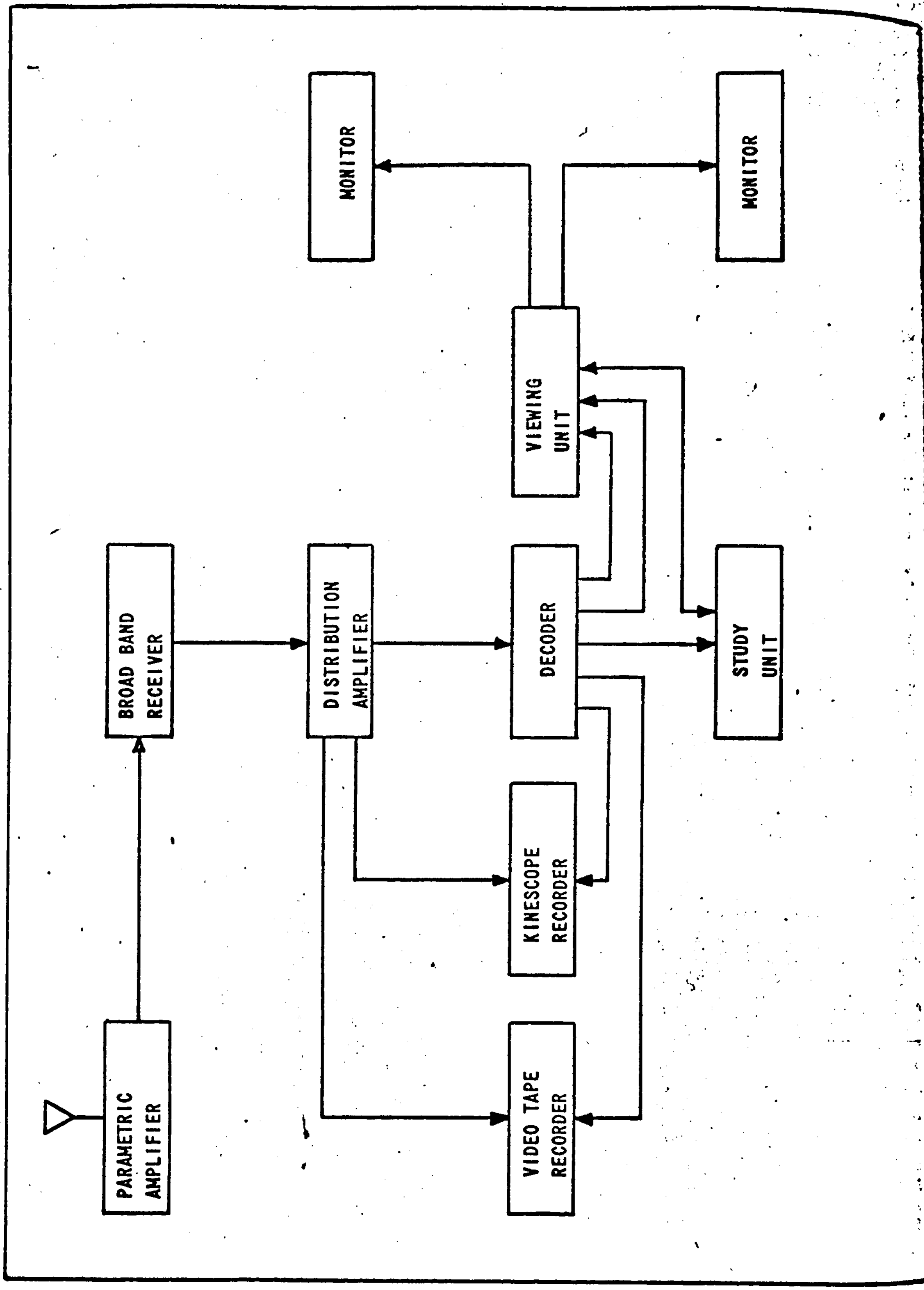


FIGURE 1. INFLIGHT EQUIPMENT


PARAMETRIC AMPLIFIER
BROAD BAND RECEIVER
DISTRIBUTION AMPLIFIER
VIDEO TAPE RECORDER
KINESCOPE RECORDER
DECODER
VIEWING UNIT
STUDY UNIT
MONITOR
MONITOR

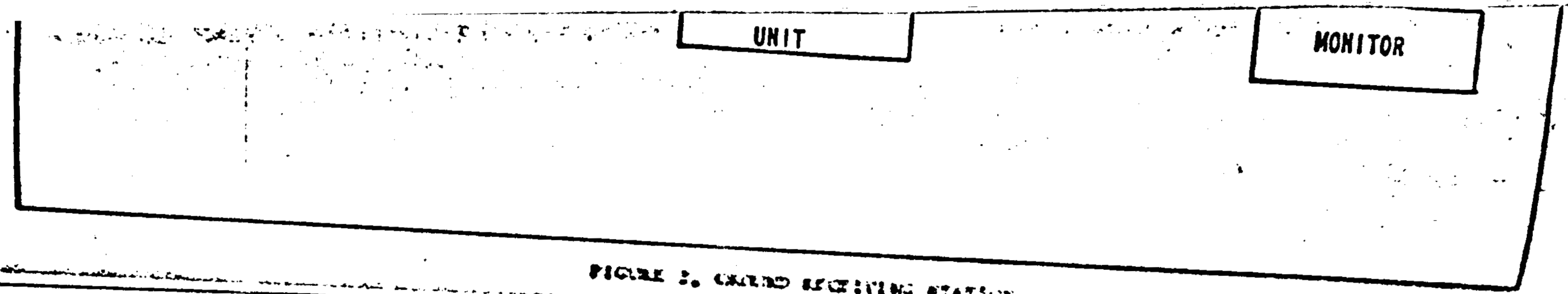


FIGURE 2. GROUND RECEIVING STATION

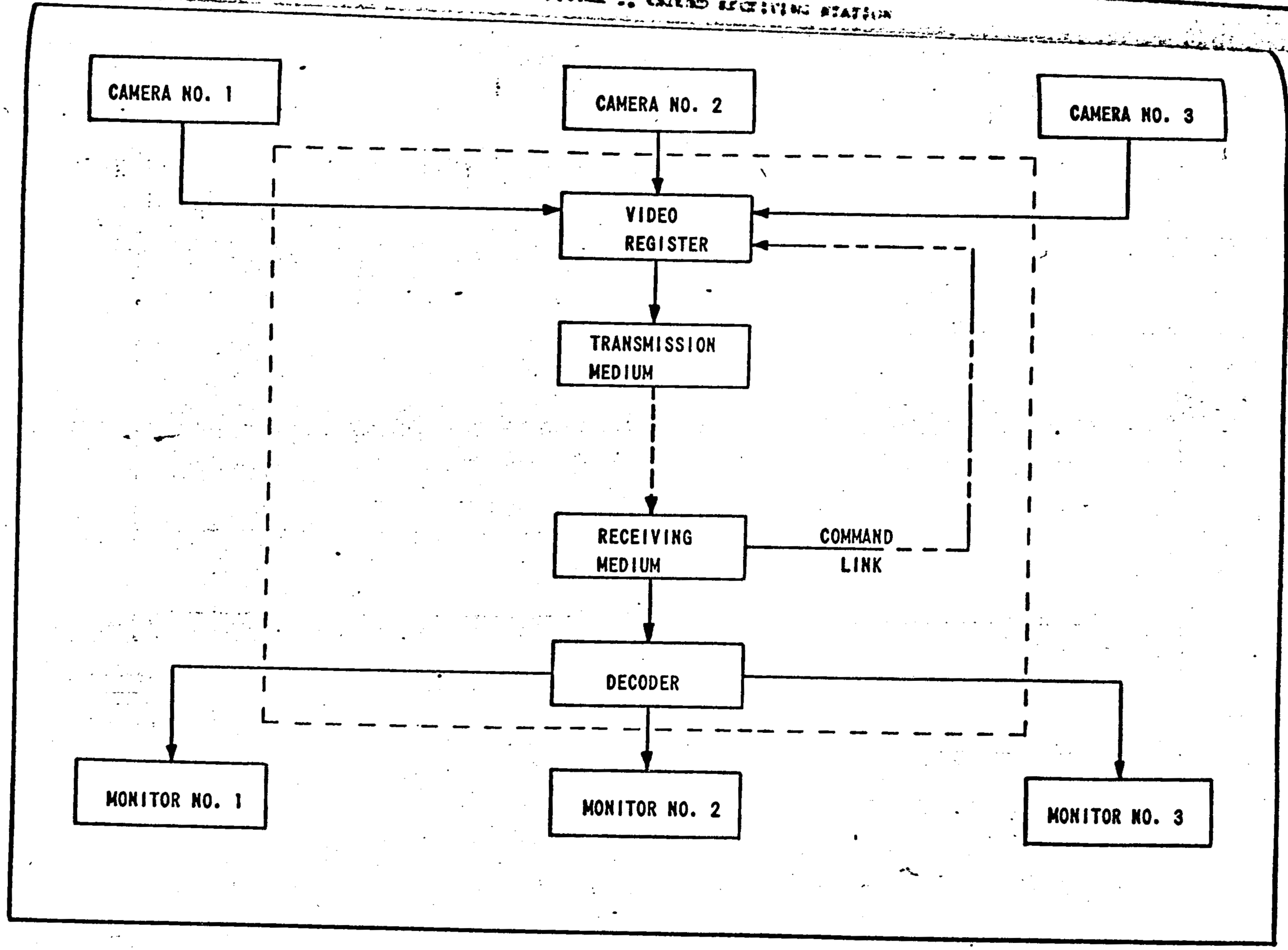
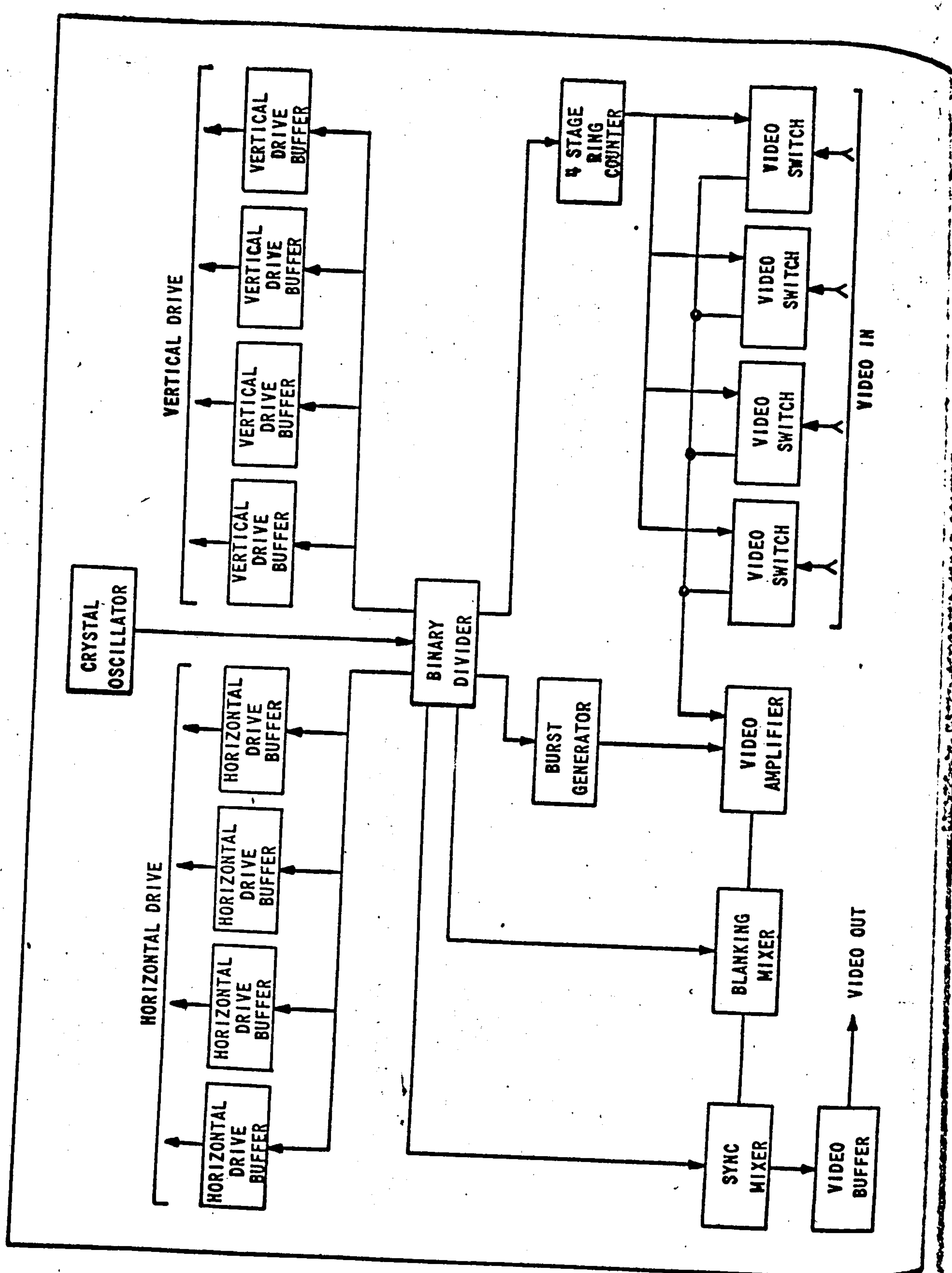


FIGURE 3. TOTAL T.V. SYSTEM BLOCK DIAGRAM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VERTICAL DRIVE BUFFER
VERTICAL DRIVE BUFFER
VERTICAL DRIVE BUFFER
VERTICAL DRIVE BUFFER
4 STAGE RING COUNTER
VIDEO SWITCH
VIDEO SWITCH
VIDEO SWITCH
VIDEO SWITCH
VIDEO IN
CRYSTAL OSCILLATOR
BINARY DIVIDER
HORIZONTAL DRIVE
HORIZONTAL DRIVE BUFFER
HORIZONTAL DRIVE BUFFER
HORIZONTAL DRIVE BUFFER
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BURST GENERATOR
VIDEO AMPLIFIER
BLANKING MIXER
SYNC MIXER
VIDEO BUFFER
VIDEO OUT

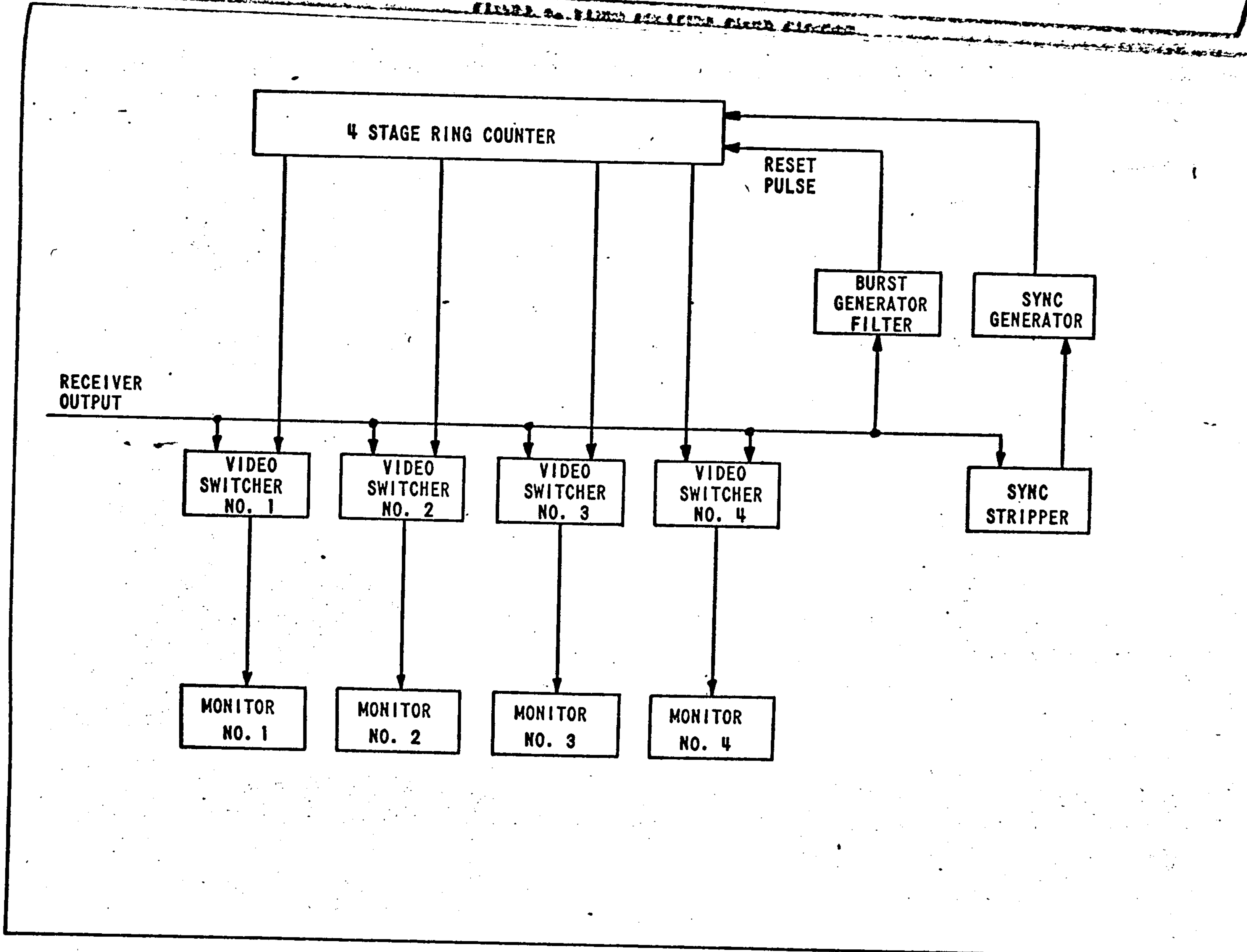

FIGURE 5. VIDEO DECODER

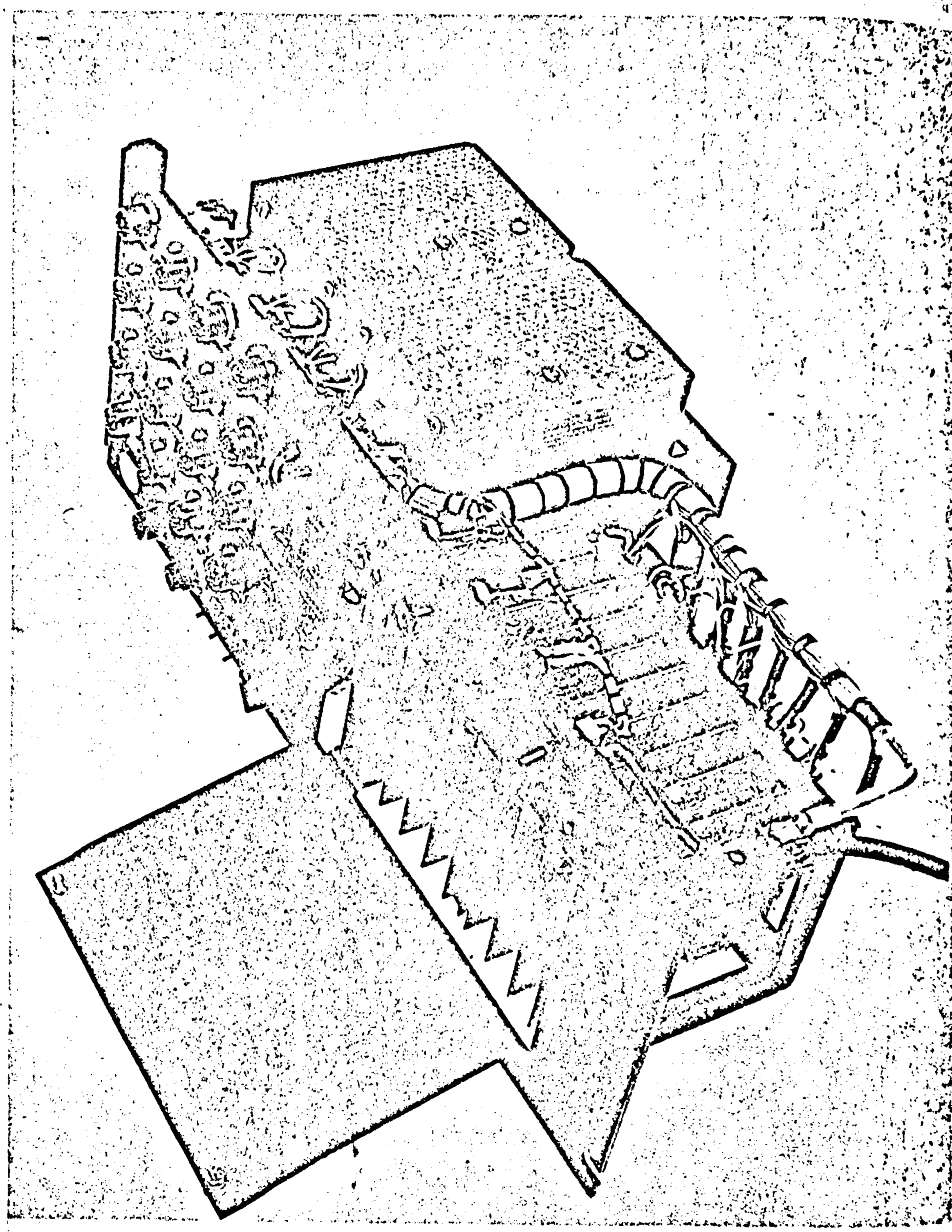

FIGURE 6. VIDEO DECODER

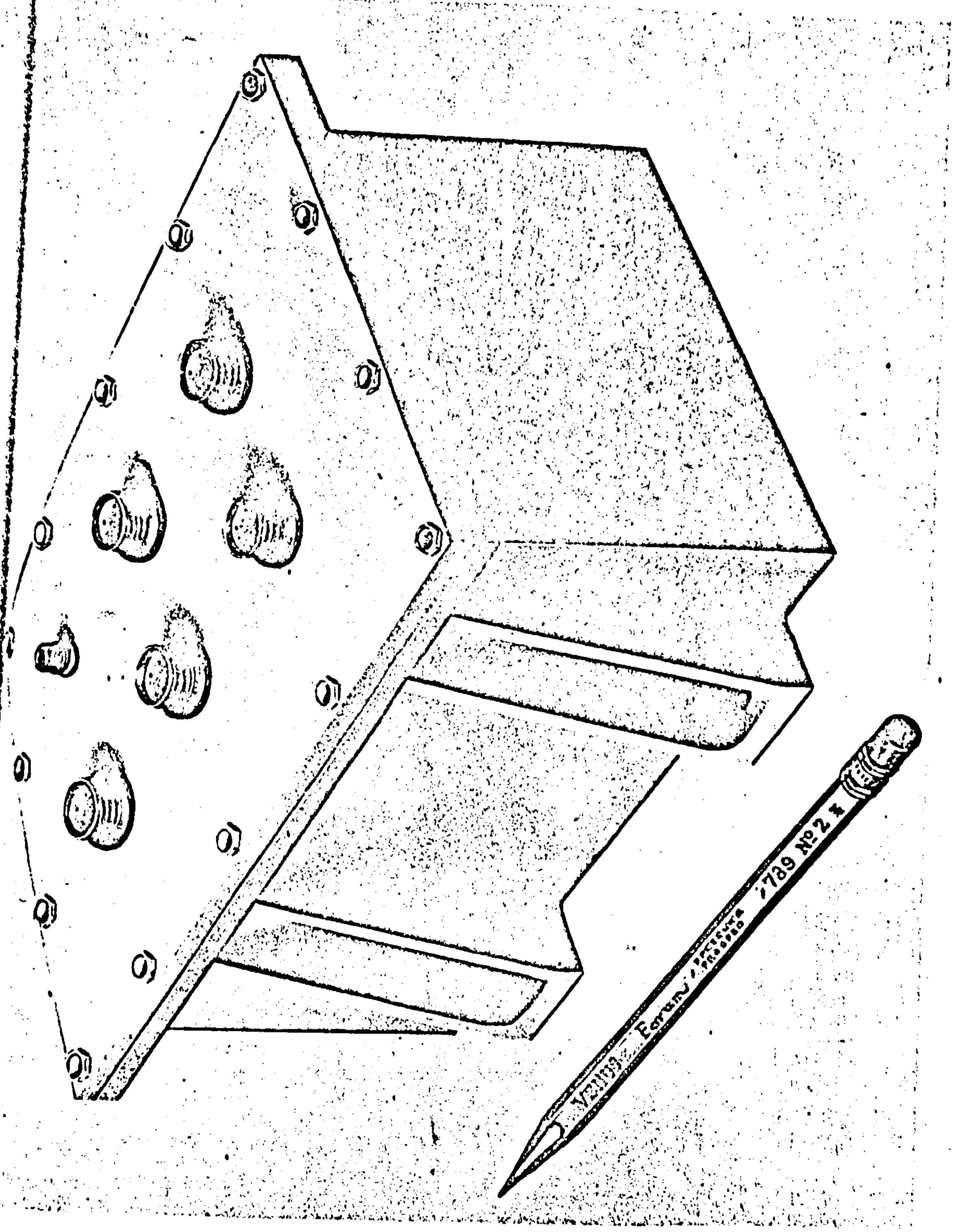

FIGURE 7. VIDEO REGISTER

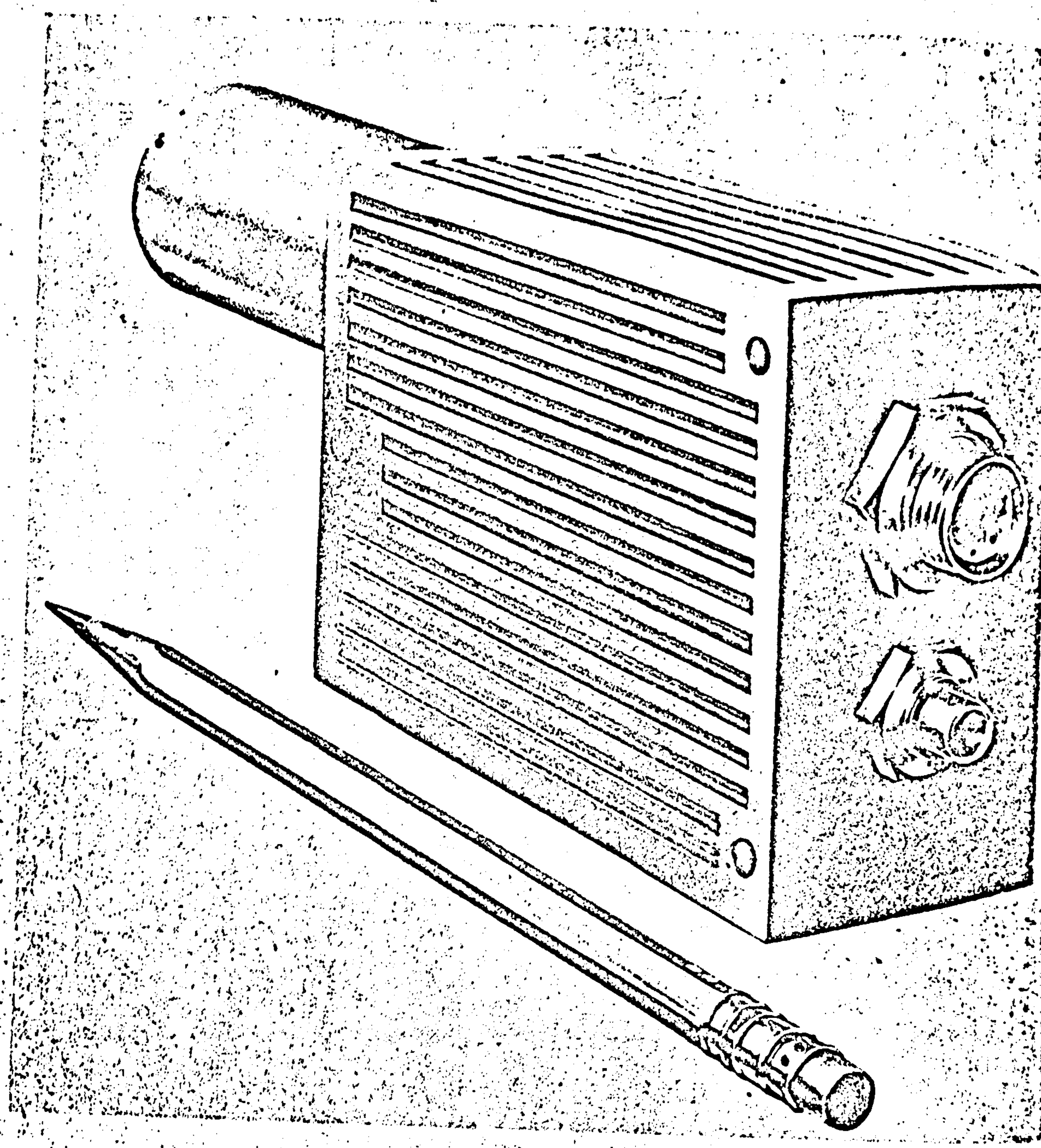

FIGURE 8. MINIATURE T.V. CAMERA